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ABSTRACT

This guide is intended to support a high school specialization course in materials and processing technology. The document contains three sections: (1) information on using the material; (2) a set of instructor guides for eight instructional units; (3) 15 technological activity modules and teacher and student instructions for their use; and (4) resources. The set of instructor guides contains instructional units on an overview of materials and processing technology, technological procedures, materials technology fundamentals, construction technology fundamentals, manufacturing technology fundamentals, materials and processing technology, careers and leadership roles in materials and processing technology. Each guide contains a sample set of competencies, subject matter content, teacher plans and activities, student activities, and a list of resources and references. The technological activity modules are a set of representative activities that may be used to address each instructional unit's goals. The guide includes modules on problem solving, fiberglass fabrications, nondestructive testing, bridge construction, construction projects, concrete processing, jigs and fixtures, automated manufacturing, robotics, mass production, forming and managing a company, and career and leadership development. Each module includes an instructor component (objectives, competencies, materials list, teaching suggestions, and pre- and posttests with answers) and a student component (competencies, glossary, materials list, activities, and pre- and posttests). The resource section contains a 13-page list of curriculum guides, textbooks, and references; lists of periodicals, publishers, media sources, resource centers, suppliers, and associations; and sample forms. (CML)

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Instructor Guide

MISSOURI INTRODUCTION TO MATERIALS AND PROCESSING TECHNOLOGY

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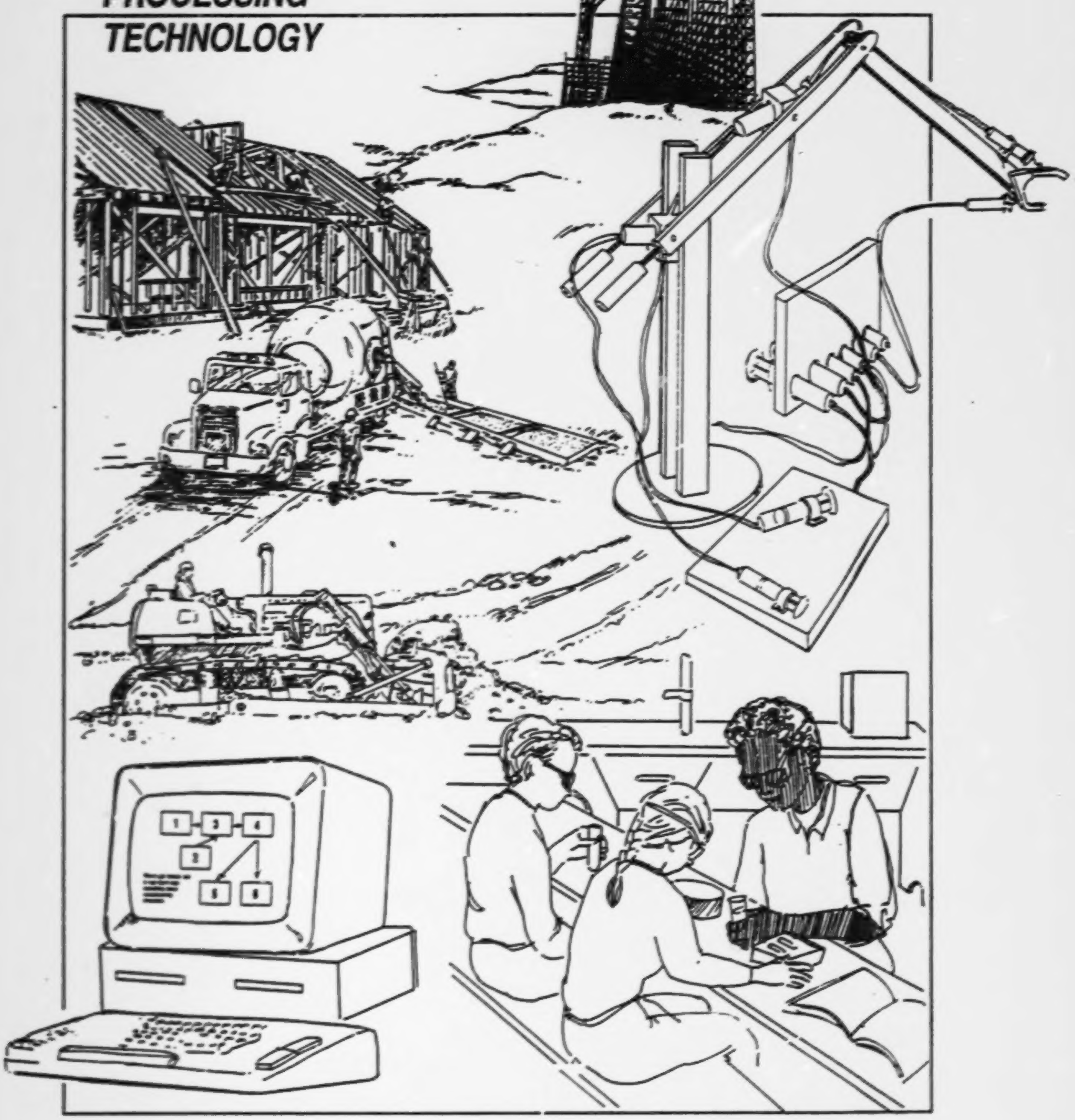

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Available from:

Instructional Materials Laboratory, 2316 Industrial Drive
University of Missouri-Columbia, Columbia, Missouri 65202
Toll free numbers: 1-800-633-5937, in Missouri 1-800-392-7217

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Missouri

Introduction to Materials & Processing Technology Guide

Advisory Committee

Eldon Divine
Department of Technology
School of the Ozarks

Dan Eckard
Industrial Technology Education
Warrensburg Middle School

Dwight Hart
Practical Arts
Hazelwood Central High School

Jim Kyd
Industrial Technology Education
South Callaway R-2 School

Jack Landers
Manufacturing Technology
Central Missouri State University

Steve Murray
Industrial Technology Education
West County R-IV High School

Peggy Porter
Association of
General Contractors of Missouri

Charles Raggo
Vocational-Technical Education
North County Voc.-Technical School

Gary Vass
Industrial Technology Education
Sherwood Cass R-VIII (Creighton)

Field Test Team

Mark Arnold
Thayer R-II High School

Donald Bradshaw
Warrenton High School

Bill Fuemmeler
Boonville High School

Eddie Goins
Ozark R-6 High School

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Palmyra Middle School

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Willie Horsely
Kansas City (MO) Schools

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Mike Maxwell
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John McGee
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Robidoux Middle School

Charles Rauls
Rolla High School

Ray Riley
Liberty Junior High School

Ahmed Sabie
St. Louis Public Schools

Mike Wackerman
Camdenton Junior High School

Ben Yates
Hickman (Columbia) High School

Project Directors:

Michael J. Dyrenfurth, Professor
Industrial Education

Dan Stapleton
Instructional Materials Laboratory

Phyllis Miller
Instructional Materials Laboratory

Project Researcher/Writers:

Yusuf Al-Hassan
Rodney Custer

Senior Graphic Designer:

Crystal Dietiker

Department of Practical Arts & Vocational Technical Education
College of Education
University of Missouri-Columbia

Editor:

Carol Buckels

Project Monitor:

Mr. Stephen D. Coffman
Industrial Technology Education Supervisor
Division of Vocational and Adult Education
Missouri Department of Elementary
and Secondary Education

Foreword

This guide is dedicated to the improvement of Industrial Technology Education in Missouri and to all of the dedicated instructors who work hard at this challenge each day! As such, this guide:

- is intended to be the Missouri Industrial Technology Education teacher's primary resource for planning, implementing and instructing materials and processing technology courses,

- is further intended to provide Industrial Technology Education students with guidelines for learning about key technological activities relevant to materials and processing technology, and

- is also designed to help direct Industrial Technology educators and students to references where they can find additional information about materials and processing technology.

How can this guide help me?

If you want to:

1 Plan major instructional units for Materials & Processing Technology

Green

- Unit 1. Materials & Processing Technology Overview
- Unit 2. Technological Procedures
- Unit 3. Materials Technology Fundamentals
- Unit 4. Construction Technology Fundamentals
- Unit 5. Manufacturing Technology Fundamentals
- Unit 6. Materials & Processing Technology Applications
- Unit 7. Careers in Materials & Processing Technology
- Unit 8. Leadership Roles in Technology

2 Teach Technology Activities

White

- TAM 1. Motivation/First Week Production Activity
- TAM 2. Problem-solving
- TAM 3. Glass Fabrication and Processing
- TAM 4. Fiberglass Fabrication
- TAM 5. Nondestructive Testing
- TAM 6. Bridge Construction
- TAM 7. Construction Projects
- TAM 8. Concrete Processing
- TAM 9. Jigs and Fixtures
- TAM 10. Automated Manufacturing
- TAM 11. Robotics
- TAM 12. Mass Production
- TAM 13. Forming and Managing a Company
- TAM 14. Career Development
- TAM 15. Leadership Development

3 Identify useful resources

Blue

- Part 1: Books and Resources
- Part 2: Periodicals
- Part 3: Publishers
- Part 4: Media Sources
- Part 5: Resources
- Part 6: Sample Suppliers
- Part 7: Associations
- Part 8: Useful Forms
- Part 9: Revision Form

Acknowledgements

This Introduction to Materials and Processing Technology Guide is designed to be specifically useful to Missouri's Industrial Technology (Industrial Arts) education teachers. It builds on, and is consistent with, the foundation established by the Missouri Industrial Technology Education Guide, and the junior high/middle school guides for ITE (Introduction to Industrial Technology Education, Exploration of Industrial Technology Education). In addition, this document, by focussing specifically on materials and processing technology, represents the first high-school-level curriculum guide since Missouri's redirection of its entire ITE program.

This guide could not have been developed without the generous assistance of many individuals and groups. Clearly, the members of the project's advisory committee, as named on the frontispiece, are prime examples of such dedication. In many ways, this Guide is more a product of their insights than those of the project writers.

Similarly, the members of the project's fieldtest team made significant contributions by helping insure that the Guide's contents were, above all, feasible for implementation in Missouri's varied school settings.

The Guide also includes much of the good practice fostered by Missouri's university and college teacher educators. Therefore, appreciation is extended to my present and former colleagues, at UMC and at each of the other state institutions, for their willingness to share their work.

The project team also wishes to acknowledge the cooperation and contributions of many colleagues in other states. After all, this Guide represents a compilation of the best thinking of the profession, regardless of where it is found. As such, input from Arizona, Georgia, Illinois, Iowa, Kansas, Nebraska, New Jersey, North Dakota, Texas, Utah, Virginia, West Virginia and Wisconsin publications and supervisors made significant contributions, which we certainly appreciate.

Stephen Coffman, the state's Industrial Technology (Industrial Arts) Education supervisor, deserves special acknowledgement and credit for this Guide. His initiative in conceptualizing and funding a long range and continuing plan for the state's development of a consistent series of industrial technology education guides made possible Missouri's bold step into the technological future. Similarly Carol Buckels', Rod Custer's and Yusuf Al-Hassan's dedicated work, insightful writing, and constructive interaction made essential contributions to the overall success of the Guide. Dr. Phyllis Miller, the project's co-director, did much to make the project feasible through her careful attention to detail and project facilitation.

In keeping with a fine tradition of supporting the profession, Delmar Publishers Inc. has continued helping Missouri's teachers. In this case, their sponsorship of the binders to house the Guide enables us to use a looseleaf fomat that will make it easier to keep the Guide up-to-date. To Mr. John Hutchinson, Missouri representative for Delmar and to the corporation itself, we extend special appreciation. Special recognition must also be extended to Rosalyn Ali. Without Rosalyn's enthusiastic contributions to the project's operation and her tireless work in entering and word processing countless revisions, this Guide simply would not have reached print.

To all of the above, and to the many others unnamed because of space limitations, the project director, on behalf of Missouri's Industrial Technology Education profession, appreciatively acknowledges his debt.

Michael J. Dyrenfurth
June 1989

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TAM 6.	Bridge Construction	6:	1- 7	1-11
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How To Use This Guide

This guide consists of three sections in addition to these prefatory remarks. Section I is the Instructor's Guide, Section II contains a sample set of Technology Activity Modules and Section III lists key resources and other helpful materials.

Section I – the Instructor's Guide contains:

- Competencies for each of the eight major instructional units
- Instructional plans for each unit
- Content outlines for each unit
- Teacher and student activities for each unit
- Sample resources for each major unit

Section II -- the Technology Activity Modules contain:

- A set of representative activities that may be used to address each major unit's goals
- Instructor suggestions for each TAM
- Student instructions for each TAM

Section III – the Resource Section contains:

- A detailed list of resources; that is, curriculum guides, textbooks, and related references; useful to instructors and students
- A sample set of useful periodicals, publishers, media sources, resource centers, suppliers and associations
- Some sample forms

Time Frame for Instructional Delivery

The instructional units outlined in this guide may be used for courses of varying length. The duration of such courses might range from a minimum of one quarter to a maximum of one year (two semesters). Instructors are encouraged to carefully consider the emphasis placed on each unit to insure that at least some content from each is covered in every course. Units may be shortened by reducing the amount of activity and/or presentation time or by reducing the number of competencies actually addressed. Units may be lengthened by increasing activity time and/or by increasing the depth of treatment for key topics.

Context for Introduction to Materials and Processing Technology within Industrial Technology Education

The Introduction to Materials and Processing Technology Guide is intended to support the first high school specialization course beyond the broad-based foundation established by the Introduction to Industrial Technology and Exploration of Industrial Technology courses. As such, it is designed to build upon this previous work and to guide students to the mastery of higher level cometencies.

Scope and Approach Employed

This guide is intended to provide more input than can probably be incorporated into any single course. Therefore the ITE instructor is well advised to select key portions to be incorporated within his/her ongoing instruction. In addition, instructors should note that the Technology Activity Modules (TAMS), the suggested instructor and student activities and the resources listed represent but a portion of those that could be listed.

Missouri
Introduction to Materials & Processing Technology Guide

Section I: Instructor Guides

This section contains suggestions about how the materials and processing technology cluster might be taught as a ninth through eleventh grade course. Eight units are suggested and each is detailed separately. The locus of each unit within the overall course is depicted in the unit's cover graphic. Each major instructional unit in this Introduction to Materials and Processing Technology Guide contains a sample set of competencies (coded to the content outline) that describe what students should be able to do when they complete the unit. It should be noted that the guide is intended to be representative rather than exhaustive. This means that it does not pretend to include all that could be taught pertaining to materials and processing technology. At the same time, it does encompass so much information and include so many activities, that it is difficult to imagine any one course covering it all. This leaves the ITE instructor in charge of content selection and synthesis into a manageable course.

To facilitate the task, four columns are used to present useful information about each unit. The Content column presents a structural outline of the key concepts and information. The Teacher Plans & Activities column describes some typical activities that instructors can do to help students develop the desired competencies. The Student's Activities column suggests selected things students can do as part of their work during the unit. Finally, the Resources & References column lists a sampling of important resources supportive of the unit. The Resources & References column lists suggestions for support and/or reference materials useful to the topics and activities in the columns to the left. Some addresses are listed here but most are detailed in this guide's Section III's various parts, e.g., resources, publishers, media suppliers, resource centers, and suppliers.

Each unit also includes a graphic that suggests one way of arranging the lessons used to teach the unit. In these graphics several codes are incorporated to help even more. Rectangles are used to indicate key lesson topics. When several white rectangles are shown within a larger gray rectangle this indicates that these topics might be combined into a single lesson. This is suggested whenever time constraints require a more cursory treatment of the unit's content to that of related technology courses in ITE's scope. Ellipses indicate topics that bridge between materials and processing technology and the other industrial technology clusters and/or the other school subjects.

Although the course is organized into eight separate units, often activities in one unit could be effectively used in other units as well. Also some units, e.g., the careers one, might well be taught as a distributed unit instead of as a freestanding one. Such decisions of course are the individual instructor's to make.

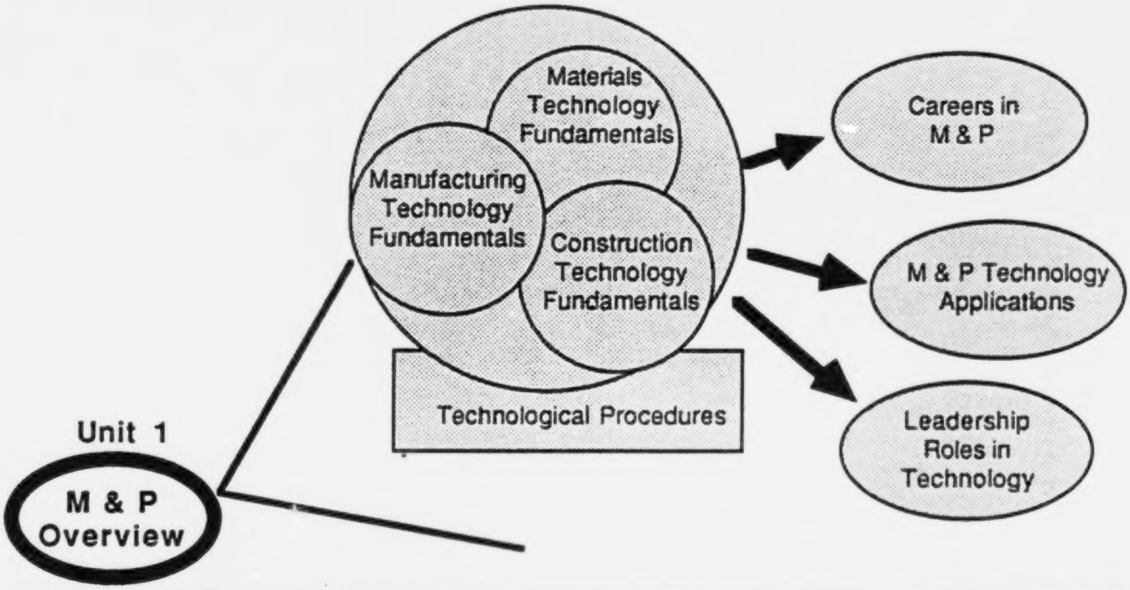
Incorporated into this guide is the continuum ranging from material extracting/ harvesting through use to recycling. The sequence of raw material extraction, primary processing to yield standard stock, the design and production cycle and then the post-production phase (service, recycling...) is embodied in most of the course' units.

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 1: Materials & Processing Technology Overview


Materials Technology Fundamentals
Manufacturing Technology Fundamentals
Construction Technology Fundamentals
Technological Procedures
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology
Unit 1
M & P Overview

The purpose of this unit is to provide a comprehensive introduction to materials and processing technology. The unit is designed to create a broad framework for more concentrated study in successive units.

Unit One: Materials & Processing Technology Overview

OBJECTIVES: The purpose of this unit is to provide a comprehensive introduction to materials and processing technology. The unit is designed to create a broad framework for more concentrated study in successive units.

COMPETENCIES -- The student will be able to:

1. Define and explain the technical terms and concepts used to describe the principles, mechanisms and systems associated with materials & processing technology. (1,I)*
2. Describe and illustrate major materials processing processes, their components and their key variables. (1,I,A,B,C)
3. Describe the categories of materials and their primary characteristics. (1,I,A)
4. Describe the relationship of materials processing technology to manufacturing systems. (1,I,B)
5. Describe the relationship of materials processing technology to construction systems. (1,I,C)
6. Describe the interface between materials & processing and communication technology. (1,II)
7. Describe the interface between materials & processing and energy & power technology. (1,III)
8. Provide examples of the major types of materials processing systems (individual, artistic, mass, continuous, job). (1,IV)
9. Apply the basic scientific foundations of chemistry, physics and mathematics to explain the operation of key materials & processing technology processes. (1,V)
10. Explain selected chemical concepts involved in the processing of metals, plastics, ceramics and cellulose materials. (1,V,A)
11. Explain selected physics concepts involved in the processing of metals, plastics, ceramics and cellulose materials. (1,V,B)
12. Perform calculations and conversion operations pertinent to size, volume, area and density. (1,V,C)
13. Describe Cartesian coordinate systems and their application to computerized production processes. (1,V,C)
14. Provide examples of the positive and negative impacts of materials & processing technology on society in economic, environmental, psychological and sociological terms. (1,VI)
15. Demonstrate the safe and proper use of materials & processing technology tools, equipment, materials and processes to manufacture and construct products. (1,VII)
16. Apply planning, organizing, controlling, producing and quality control processes to manufacturing and construction projects. (1,VIII)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

Content

I. Overview: Components of Materials & Processing Technology

  A. Categories of Materials
    1. organic, e.g.,
      - Woods, plastics...
    2. metallic, e.g.,
      - Iron, steel, aluminum...
    3. ceramic, e.g.,
      - Cement, glass, abrasives...

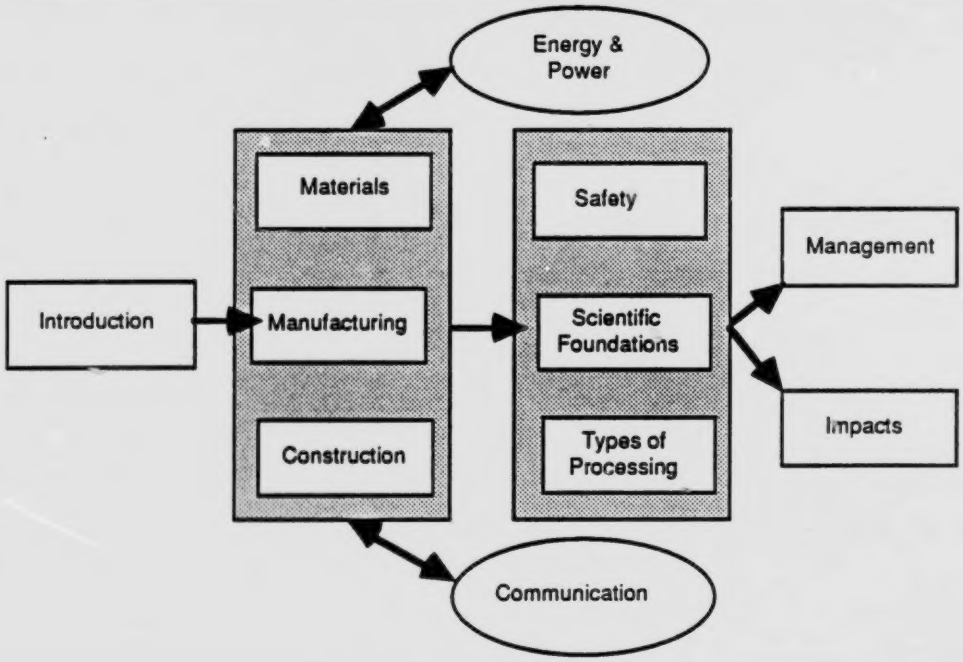
  B. Manufacturing
    1. Factory/workshop site setting
    2. Organization
    3. Facility
    4. Human Resources
    5. Finances

  C. Construction
    1. Site Setting
    2. Organization
    3. Facility
    4. Human Resources
    5. Finances

Teacher Plans & Activities

- Bring a series of items to class as a first day activity, (e.g., brass water valve, hole punch, portable radio/cassette, compact disk, skateboard, etc.) Have students brainstorm the materials and processes by which items were made. Explore other alternatives and possibilities by which they could have been made.
- Make transparencies showing material types.
- Develop a slide set showing and contrasting manufacturing and construction settings. Emphasize differences in materials, methods, tools and equipment, etc.
- Follow the slide presentation with discussion of differences and similarities between manufacturing and construction settings.
- Illustrate (with sample materials and objects) the basic materials classifications.
- Lead a class discussion of the reasons why certain materials are selected for applications in various industries, e.g., weight, strength, safety, economics.

Lesson/Activity Outline



☐ Key Lesson ▨ Consolidation Suggestion ○ Interface Topic

Student Activities

- TAM #1: First Week Production Activity.
- Tour school, identify materials used in building; inspect above ceiling tile, in boiler room, etc. Analyze choice of materials--why are they used?
- Inspect plans for building and compare to actual facility. Identify differences. Develop suggestions for improvements.
- Plan addition. Sketch to communicate ideas to contractor. Assess feasibility.
- Mass produce a predesigned product using manufacturing or construction technology.
- Make a list and illustrate use of ten items made from each material classification.
- Develop a listing of as many different materials as you can which are used to make an automobile and/or house.
- Take a field trip to a construction site. Look for materials, processes, tools and equipment used.
- Take a field trip to a manufacturing facility. Watch for materials, processing methods, equipment, skill levels, materials routing methods, etc.

Resources & References

- Mid-America Vocational Curriculum Center Guide, "Exploring Manufacturing Technology" (resource for transparency masters).
- The technology spiral (YMT video #3419-2: MVRC)
- Markert (1989). Contemporary Technology.
- Diversified Technology (n.d.). Introduction to Technology Module.
- Overview of Technology (ETE video & Inst. Matls./IML).

Content	Teacher Plans & Activities
I. Overview: Components..., continued	• Organize a class presentation which clearly distinguishes between the manufacturing and construction areas. • Present clear definitions of organic, metallic and ceramic areas. Invite students to try to develop another classification for materials not covered in these classifications, e.g., industrial gasses.
II. Interface to Communication Technology A. Materials Testing and Conditioning 1. Computer data acquisition 2. Graphic result display B. Manufacturing 1. CAD (Computer Assisted Design) 2. CAM (Computer Aided Manufacturing) 3. Integrated Manufacturing Systems 4. Robotics C. Management 1. Quality Assessment and Control - Monitoring results - Charting results	• Show videos or films illustrating key processes. • Consult with program advisory committee about what's available. • Conduct a brainstorming session of the uses of the computer in materials testing, manufacturing, assembly, construction, design and management situations. • Demonstrate the use of a CAM system. • Develop a presentation on CIM (Computer Integrated Manufacturing) emphasizing the use of the computer through design, manufacturing, inventory management and cost accounting. • Organize a field trip to a facility which uses robotics to conduct welding, assembly, or materials handling operations. • Organize a debate with advocacy for and against using computers in manufacturing settings.
III. Interface to Energy & Power Technology A. Instrumentation systems 1. Machine/Process readouts 2. Indicators B. Control systems 1. Manual, e.g., - speed, direction 2. Computerized - CNC (Computer Numerical Control) machine C. Transportation 1. To/from plant/site - Rail 2. Within plant/site - Conveyor D. Energy conversion systems 1. Electric motors 2. Internal combustion 3. Direct conversion - Solar cells - Windmills	• Discuss the role of instrumentation in manufacturing, construction, materials testing, etc. • Have students brainstorm the ways in which instruments are used in specific settings (examples could include a CNC machine, an automobile, an aircraft, a computer, a moisture tester, a stud finder and more).

Student Activities	Resources & References
• Discuss the advantages and disadvantages of using the computer to design a product for manufacturing. • Generate a drawing of a part using a CAD system. • Construct a robot to perform a manufacturing operation. • Move a syringe robot through a series of operations with a microcomputer program. • Convert "people instructions" into a machine language/code that can be understood by a robot.	• Harms (1988). Communication Technology Activities. • Communication - The Expanding World (YMT video #3423-0: MVRC). • Barden & Hacker (1990). Communication Technology. • "Creative Computer Graphics," video on computer graphics - Dan Ross Eaker, Computer Pictures Magazine, 330 W. 42nd St., New York, NY 10036 (212) 947-0020. • Resources from Modern Talking Pictures (See - latest catalog for listings). • Introduction to Communication (ETE video & Inst. Matls./IML).
• Bring a car to the laboratory and identify instrumentation, control and energy conversion systems on it. How do they operate? What materials combine to make it work? How were the components made? • Make a list of at least ten situations where instrumentation is used in a manufacturing plant. • Develop an idea for the electronic dream house of the future. (Ideas could include: electronically monitored and laser cut lawn care; automatic room size adjustment according to electronically monitored use patterns and traffic flow, etc.) • Make a list of the kinds of information that could be generated by sensing devices in an automobile. Use your imagination!	• Harms (1988). Energy Power & Transportation Activities. • Energy for Societies (YMT video #3420-6: MVRC). • The Changing Romance (YMT video 3424-9: MVRC). • Overview of Energy & Power (ETE video & Inst. Matls./IML).

Content	**Teacher Plans & Activities**
IV. Types of Materials & Processing Production A. Artistic B. Individual C. Mass D. Continuous E. Job	• Make a class presentation which defines and discusses the basic types of materials and processing production categories. • Organize a debate on the question, "Are the best quality products made by mass or custom production?" • Lead a discussion on the role of skill and craftsmanship in modern product development and production/construction. • Invite the owner of a custom cabinet shop to speak to the class. Direct the discussion to the tasks that his/her operation is able to perform better/worse than would be the case in a mass production setting. • Organize and manage a limited mass production activity. • Illustrate the efficiency of mass produced items as well as value of cooperative effort in design and production. • Arrange to show a film which shows processes such as tire manufacture, paint systems development, etc. (Many of these discuss the chemical and physical properties involved in manufacturing.)
V. Scientific Foundations of Materials & Processing Technology A. Chemistry 1. Atomic structure & bonding 2. Chemical formulas 3. Periodic table of elements 4. Technological applications B. Physics 1. Conservation of energy 2. Light phenomena 3. Magnetism 4. Nature of electricity 5. Kinetics & statics 6. Technological applications C. Math 1. Arithmetic operations 2. Geometric operations 3. Trigonometric operations 4. Technological applications	• Develop an illustrated presentation discussing the role of science in materials and product development. • Conduct preliminary assessment of level of math ability for the class. • Introduce the concept of mechanical properties, e.g., tensile, fatigue, shear strength, ductility, machineability, corrosion resistance, etc. • Prepare classroom demonstrations and illustrations of mechanical property changes which occur due to chemical changes. (Examples could include subjecting thermoforming plastics to heat; heat treatment of tool steel; plating to steel; salt water to steel; etc.) • Explain the process of transforming petroleum products into plastic materials. • Describe and illustrate why certain manufacturing processes work better in space (medical, certain alloying procedures, etc.).

Student Activities

- Prepare a paper on the historical development of mass production in the automobile industry.
- Conduct a debate comparing the advantages and disadvantages of custom made and mass produced products.
- Read selections from journals suggested by the instructor on skill and craftsmanship.
- Identify people-focussed articles on mass production.
- Participate in a mass production activity.
- Write a short opinion paper entitled, "The Role of the Artist in a Mass Production Culture."
- Have class design and make simple individual products (book ends, whirly gigs, CO_2 cars, etc.). Keep track of time. Then do a simple mass production run of a limited number of the same item, again keeping time records. An additional idea would be to have 2-3 groups in competition for efficiency and design.

Resources & References

- Books authored by John B. Rae on automotive history.
- Select appropriate program from television series such as NOVA, Connections, 3-2-1 Contact, Science Technology Week, Future Scan, National Geographic Explorer, Beyond 2000, Newton's Apple, Discover, etc. Contact the Missouri School Board Association for satellite programing.
- Introduction to Manufacturing (ETE video & Inst. Matls./IML).
- Historic evolution of technology may be demonstrated using "The Williamsburg Videos" (Vocational Marketing Services).

- List five manufactured products that required a chemist in order to be developed.
- Visit a plating facility to see how objects are coated with chemicals.
- Measure a crankshaft bearing journal with a micrometer.
- Develop a list of ten common alloys. What are their chemical components? How did their combination effect their mechanical properties?

- Video resources available from sources, e.g., Dupont, PPG, Martin Senour (paint systems); Goodyear, Firestone, B.F. Goodrich (tire design and mfg) and others. Get advisory council suggestions.
- Applied Physics Module #4. (Synergistic Technology Systems, PITSCO).
- Amusement Park Physics Kit. (PASCO).
- Maley (1985). Math/Science/Technology Projects.
- Mystery Matter. (Computer Program MECC).

Content	Teacher Plans & Activities
VI. Materials & Processing Technology Impacts on Society & Individuals A. Economic 1. Standard of living 2. Gross National Product B. Psychological 1. Quality of life 2. Individual stress 3. Requirements of work C. Sociological 1. Teamwork 2. Organizational structure 3. Leisure time D. Environmental 1. Thermal 2. Chemical 3. Electromagnetic	• Organize a debate on the issue, "Technology has made a positive/negative impact on life in America." Encourage students to assess the issues in terms of economic, psychological, sociological and environmental considerations. • Lead a discussion of the negative impact of fossil fuel use on the environment. • Discuss the trade-offs between economics and environmental impact. • Prepare an illustrated discussion of technology impacts in the areas of economics, sociological and psychological health and environmentalism. • Invite a psychologist in to discuss the effects of technology on emotional health. • Lead a brainstorming session of future impacts of technology. Will the impact be positive or negative? What new directions will emerge? • Select a science fiction movie showing technology possibilities for future.
VII. Safety A. Trade & Labor Organizations Policies & Procedures 1. Union requirements 2. Trade organization recommendations B. Government Organizations and Regulations 1. OSHA 2. NIOSH C. Manufacturing & Construction Policies and Practices 1. Individual 2. Corporate	• Show films on safety related to materials and processing. • Develop a presentation emphasizing the critical importance of safety issues for materials and processing technology. • Invite a government or trade association official to speak to the class on safety related issues, e.g., costs, policies, regulations, etc.
VIII. Management in Materials & Processing Technology A. Production Management B. Personnel Management C. Financial Management D. Quality Control Systems E. Planning & Organizational Systems	• Develop a presentation outlining and illustrating the processes that computers perform in management. • Develop and present a model for research and development. • Discuss the relationship of mass production to cost control. • Develop a hypothetical situation where a product is to be produced in your lab. Have the class prepare a production flow chart and simple shop layout plan for maximized production efficiency. • Outline career opportunities in management.

Student Activities	References & Resources
• Make a list of manufactured products that have had a positive psychological impact on you or your family. • Prepare a paper on "The Warming of the Earth's Atmosphere." • Interview a production line or construction worker. Attempt to identify how the job contributes/detracts from his/her emotional health. • Make a scrapbook, of newspaper and magazine clippings, with sections organized to present opposing views on key technological issues.	• Huxley's Brave new world; Toffler's books; science fiction movie • Hacker & Barden (1988). Living with technology. • Hacker & Barden (1988). Technology in your world. • Living with technology (You, Me & Technology video #3417-6: MVRC). • Exploring Technology (Bergwall) • People, Technology & the Environment (ETE video & instr. matls./IML)
• Visit an employer in either a manufacturing or a construction company. Research information on the following: The estimated costs associated with safety and accident prevention per year; the estimated costs associated with accidents and unsafe practices per year. Compare these data to the national statistics (from library). • Take air and/or water samples. Test or have them tested for pollution, e.g., radon levels.	• Developing Shop Safety Skills (IML 10-7900). • Center for Occupational Research & Development (1981). Safety with Hand and Portable Power Tools. • Dyrenfurth & Linhardt (1981). Vocational Safety Guide. • Risk Safety & Technology (YMT video #3428-1" MVRC) • Power Tool Safety & Operation (IML 10-7970). • Obtain program advisory council suggestions about films other useful resources, e.g., welding companies for welding safety films, resources from OSHA, etc.
• Obtain an organization flow chart from a manufacturing or construction company. Ask company representative to clarify and illustrate. Ask what they would like to change to make the organization work better. • Visit an individual responsible for quality control in a manufacturing or construction setting. Inquire into what techniques or factors most influence quality. • Develop a list of merits of the free-enterprise system. • Develop a paper entitled, "What Japan has that America Doesn't"	

Missouri

Introduction to Materials & Processing Technology

Unit 1: Materials & Processing Technology Overview

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

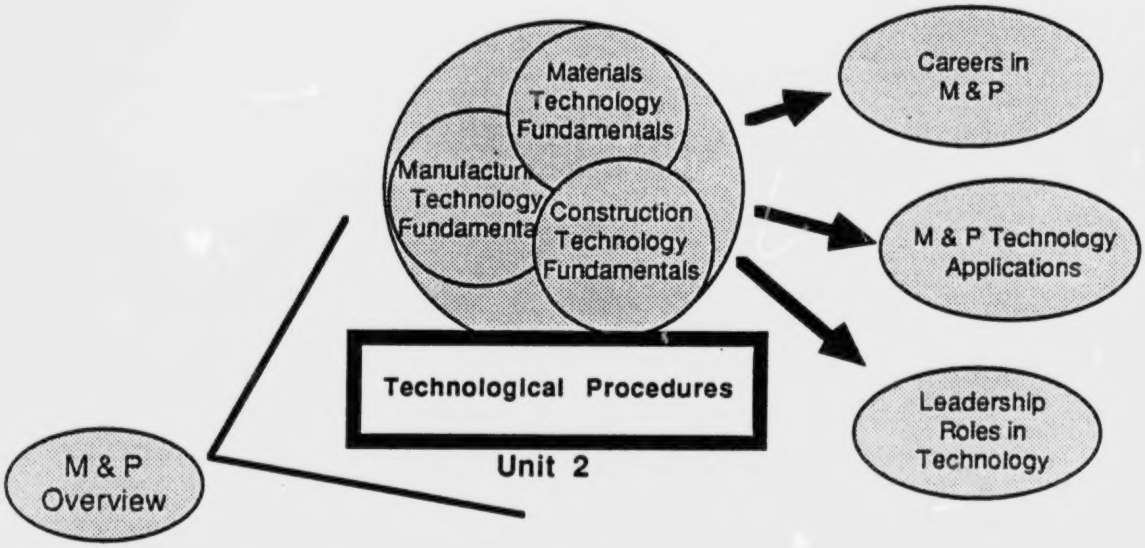
Advisory Group Input:

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 2: Technological Procedures


Materials Technology Fundamentals
Manufacturing Technology Fundamentals
Construction Technology Fundamentals
Technological Procedures
Unit 2
M & P Overview
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology

The purpose of this unit is to develop the characteristics, qualities and roles of leadership, particularly as they pertain to technological settings. The focus will be on personal, occupational and organizational skills.

Unit Two: Technological Procedures

OBJECTIVES: The purpose of this unit is to introduce technological procedures related to the access, communication and processing of information in the materials and processing technology arena. The focus will range from problem solving to research and development and to the computerized processing of information.

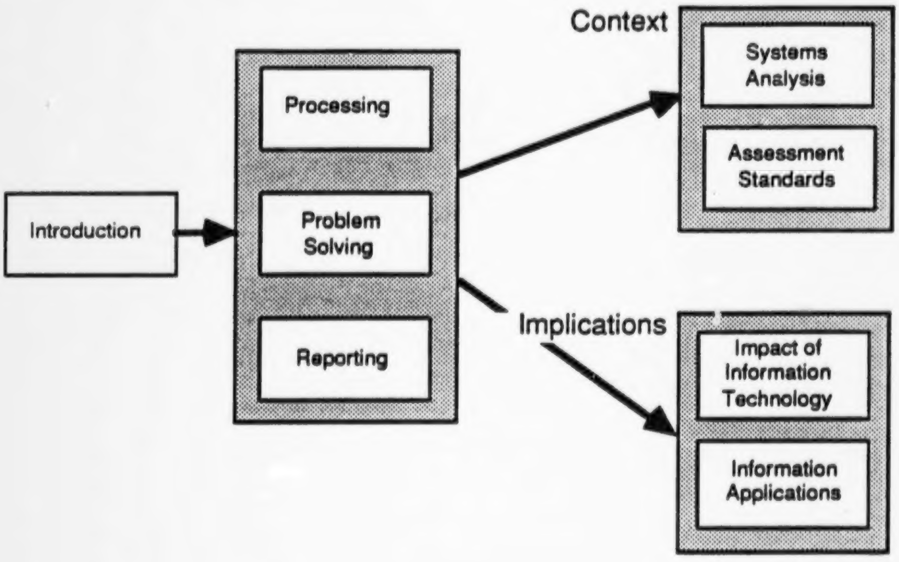
COMPETENCIES -- The student will be able to:

1. Use commercial information accessing/retrieval/storage mechanisms (such as Sweets, Mitchell's Manuals, microform parts lists, computer data bases etc.) to locate, secure and refile needed technological information. (2,I)
2. Process technological information using data analysis and data reduction methods such as graphing and computer or manual statistical process control procedures. (2,II)
3. Identify strengths and limitations of computers. (2,II)
4. Describe how computers are interfaced with other machines to operate processes. (2,II)
5. Report technological information using graphic, chart, tabular and textual presentations in printed media or electronic forms. (2,III)
6. Employ individual and group problem-solving processes to evolve alternative solutions, to assess and to implement solutions to assigned technological problems. (2,IV)
7. Take a technological system and develop a detailed list of its major building blocks, system and building block inputs, system and building block outputs, statement of system goal, feedback mechanism and sketch its configuration. (2,V)
8. Describe in sequence the steps used in problem solving, research & development.(2,IV,A & B)
9. Design a technological system, using existing and/or newly developed components and/or building blocks, to meet an assigned set of design specifications. (2.VI)
10. Use a selected computer language to perform a basic industrial function. (2,VII)
11. Conduct technology assessment studies to evaluate the impacts and benefits of a specific technology or technological solution. (2,VIII)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

Content	Teacher Plans & Activities
I. Information Accessing/Retrieval/Storage A. Trade & Government Publications B. Computer Data Bases C. Reference Publications & Sources	• Demonstrate problem solving activity to show information access on a problem of interest to students, e.g., How to build a stereo speaker. • Show and demonstrate the use of Sweets or Mitchell's manuals. • Demonstrate the use of a computerized data base. (Local autoparts house often use a data base). • Assign a simple activity project, e.g., making an item or solving a simple design problem. Have students document the steps involved in the process. Later in the semester/year assign the same activity using the documentation from this activity. The object of the experience is to emphasize the importance of thorough documentation.
II. Information Processing A. Computer/Machine Interface B. Design C. Personnel & Production Management D. Sales & Marketing E. Standards Updating	• Illustrate CAD basics using an Etch-a-Sketch. • Describe the components of a computer. Include discussion of networking. • Demonstrate a CAD system as a design tool rather than a drawing tool, e.g., visit a district office of the Missouri Highways Department. • Demonstrate using a spreadsheet to consolidate material requirements and calculate costs. • Demonstrate the use of a word processor in preparing bid specifications.

Lesson/Activity Outline


Context
Introduction
Processing
Problem Solving
Reporting
Systems Analysis
Assessment Standards
Implications
Impact of Information Technology
Information Applications

☐ Key Lesson ▨ Consolidation Suggestion ○ Interface Topic

Student Activities

- TAM #2: Problem Solving.
- Develop a data base for inventory for a school lab; materials suppliers; etc. (Simple data base programs include PC File, Apple Works, etc.)
- Sweets, Mitchell's and others. Have program advisory committee identify other appropriate resources.
- Access a database or a bulletin board with a computer and modem.
- Produce a simple letter or report using a word processor.
- Develop a drawing on a CAD system.
- Generate a bill of materials, using a spreadsheet program, for a product that you will build .
- Visit a manufacturing facility which uses computers in design, production control, management, etc.

Resources & References

- Machinist's Handbook
- NASA Tech Briefs
- All university libraries in Missouri
- Public libraries
- McGraw-Hill Technology Link computer network
- Hoffman (1986). Student's shop reference handbook
- Introduction to telecommunication (IML 20-6500)

Content	Teacher Plans & Activities
II. Information Processing, continued	• Discuss the range of computer applications in materials and processing related areas including design, product management, sales, quality control, etc. • Invite a computer equipment vendor to demonstrate appropriate hardware and software packages to the class. • Invite a guest speaker from a construction or manufacturing company which has integrated computer technology into its operation. • Take a field trip to an architect's office, a construction, manufacturing or heating/air conditioning firm, etc., which uses CAD, CIM, CAM, etc., in its operation.
III. Information Reporting A. Narrative reports B. Graphs & charts C. Displays D. Graphics E. Media presentations	• Videotape and present some effective TV advertisements. Analyze what works and what doesn't. • Show a variety of information reporting formats used in technological reporting (program evaluation and review technique [PERT] and critical path method [CPM] charts, pie charts, bar charts, text formats, etc.). • Conduct a brainstorming session of methods that communicate well with the students (sound, music, video, etc.). Examine how these same methods work in commercial information reporting.

Student Activities

- Interview an individual responsible for research and development in a local industry. Discover what steps that individual uses in addressing a research & development problem.
- Design a project that you will or could build. Include in your plan of procedure reasons for your decisions, e.g., type of joints, finish, material type, order of procedure, etc.
- Design and build a mass production project such as a picnic table. Compete against other student teams for the best design. Identify industrial designer/representative to judge designs.
- Use statistical process control procedures to evaluate production trends.
- Do research and development on the class mass-production project.
- Compile and organize a scrapbook reporting the results of a technological research problem.
- Prepare a computerized graphic (pie chart, bar chart, etc.) illustrating a set of important technological facts.
- Develop a graphic showing the percentages of your project's total cost spent for various items. Include a labor estimate.
- Produce a video or electronic slideshow illustrating graphic presentation on a technological topic of interest, perhaps explaining the Technology Student Association.
- Draw a diagram showing how a system works (microcomputer, stereo, fuel or ignition). Identify components associated with input, output, feedback, processing, etc.
- Flowchart the class mass production activity to show the results of your systems analysis.

Resources & References

- Odyssey of the Mind resources at MVRC (Missouri Vocational Resource Center), 8 London Hall, University of Missouri, Columbia, MO 65211 (314) 882-2883 or (314) 882-9610
- Anderson (1983). Technical Shop Mathematics.
- Decisions! Decisions! Decisions! (YMT video #3418-4: MVRC)
- Introduction to Microcomputer Applications (IML #20-4950/1/2/3).
- MITEA (Missouri Industrial Technology Education Association) c/o Steve Coffman, P.O. Box 480, Jefferson City, MO 65102 (314) 751-7764
- TSA (Technology Students' Association) 1914 Association Drive, Reston, VA 22090 (703) 860-9000
- IAD/AVA (Industrial Arts Division of American Vocational Association) 1410 King Street, Alexandria, VA 22314 (703) 683-3111
- ITEA (International Technology Education Association) 1914 Association Drive, Reston, VA 22090 (703) 860-9000
- Business Communication (IML 20-6005)

Content

- IV. Problem-solving Processes
  - A. Problem-solving Models
    - 1. Identify problem
      - - Analyze problem
      - - Analyze the problem's context
      - - Define & clarify the problem
    - 2. Establish solution criteria
      - - Identify appropriate criteria
      - - Identify constraints and limitations
      - - Weigh criteria according to the nature of the problem
      - - Develop a design brief
    - 3. Assemble pertinent information
      - - Search for information
      - - Analyze information
      - - Synthesize appropriate information
    - 4. Formulate alternative solutions
      - - Brainstorming
      - - Remove barriers to creative juices
    - 5. Evaluate alternatives
      - - Apply solution criteria
      - - Select optimum solution
    - 6. Implement prototype solution
      - - Develop prototype solution
      - - Produce drawings
      - - Theoretical testing
      - - Plan implementation of solution
      - - Implement prototype solution
      - - Evaluate prototype solution in operation
    - 7. Refine solution
      - - Communicate the solution
      - - Refine the prototype solution
      - - Implement the refined solution
      - - Monitor the solution appropriately
  - B. Research and Design Procedures
    - 1. Experimental method
    - 2. Testing
    - 3. Design briefs

- V. Systems Analysis & Design
  - A. Systems terms & definitions
    - 1. Components
    - 2. Subsystems
    - 3. Supra systems
    - 4. Input
    - 5. Output
    - 6. Processing
    - 7. Feedback
    - 8. Environment
  - B. Generalized systems model
  - C. Open & closed systems
  - D. Systems analysis
  - E. Systems synthesis

Teacher Plans & Activities

- Encourage students to participate in Odyssey of the Mind, TSA (Technology Student Association) and (MITEA) Missouri Industrial Technology Education Association competitions at local, regional and national levels.

- Divide the class into groups and present them with a design problem. After reporting a solution, debrief, focusing on the processes which they used to make decisions and solve problems.

- Demonstrate the problem-solving process. Illustrate with specific materials-and-processing-related situations.

- Assign students to report on a research and development problem related to their project.

- Demonstrate how to conduct a systems analysis and synthesis activity on a specific technological system. Emphasize factors, e.g., goals, input, feedback and output mechanisms. Use examples such as a student's motorcycle, automobile, computer, lawn mower, etc.

- Emphasize the importance of feedback as its own activity. Use example of student-built mass production picnic table or other project. Stop if something is going wrong or if critical path is being held up.

- Divide the class into small groups assigning each a specific system (management system, paint system, part manufacturing system, framing system, etc.). Have each group identify and sketch goals, input, feedback, and output.

Student Activities	Resources & References
• Make a coat hanger from a drawing using a pair of pliers and wire. Repeat as a class production activity. Evaluate the different levels of uniformity and quality of the two methods. • Pursue a sophisticated technology research project using state of the art information sources, e.g., space manufacturing, hazardous waste disposal, etc.	• IACP (Industrial Arts Curriculum Project). World of manufacturing. • Malo (1989). Technology workbook: Problem solving. • Missouri Science Olympiad, 1206 E. Walnut Street, Columbia, MO 65203 • Research & Design Module 5 (Synergistic Technology Systems, PITSCO) • Maley (1986). Research & experimentation in technology education. • DeVore, et al. (1989). Creativity Design & Technology. • Research & Development Unit (Parke System)
• Write a reaction to an assigned selection from Naisbitt's Megatrends. • Write a simple computer program to compute board feet.	• Review Modern Talking Pictures' film catalog for presentations about environmental problems, e.g., acid rain, ozone depletion, lead hazards, industrial pollution, cultural impact. • Gido (1985). An Introduction to Project Planning. • Naisbitt. Megatrends. • Diversified Technology. (n.d.). Introduction to systems module • Manufacturing Systems (ETE video & inst. matls./IML)
• Prepare a paper entitled, "Information Technology in the Factory of the Future." • Maintain a log that documents the key steps in your problem solving associated with a project. • Prepare a bid to general contractors for a city or other public entity. Secure a set of plans and interact with contractors to see the bid opening. Compare your bids to an actual bid. • Form a company, develop drawings, analyze costs, research materials and product standards.	

Content	Teacher Plans & Activities
VI. Technology Assessment Standards Development A. Post-implementation Evaluation B. Cost-benefit analysis C. Technology assessment process D. Technological standards	• Select several items, products or concepts which could be evaluated by the class, e.g., furniture, machine, grading system, automobile, stereo system, etc. Brainstorm the kinds of standards to which these could be subjected for evaluation. • Discuss the procedures by which technological products and procedures are developed. • Outline who is responsible for standards development in technology. Include discussion of consumer groups, engineering, government safety and environmental regulations, etc. • Bring a poorly designed or built item to class. Have students analyze what is wrong with it. Speculate why mistakes were made and suggest strategies for improvement, e.g., hand power tool, lawn mower, small appliance and more.
VII. Information Applications A. Industry B. Education C. Business D. Government E. Science	• Organize a debate with one group supporting the view that ours is the Post-industrial Communications Age. The other group will argue that ours is an Information Driven Super-industrial Age. • Assign selections from Naisbitt's Megatrends.
VIII. Impact of Information Technology A. Environment B. Social Structures C. Individuals D. Cultural Values	• Develop and present a series of illustrations of the impact of information technology in the areas of environment, culture and persons. Play the "devil's advocate."

Student Activities

- Develop a standard for noise levels in public places.
- For a project that you are designing, develop a list of standards that you will use for evaluation.
- Validate standards by conducting a survey of the consumers, or potential consumers, of the mass production project you are making.
- Prepare a bulletin board display showing how industry is increasingly using information processing. Highlight the standards necessary to accomplish this.
- Brainstorm two lists (positive and negative) dealing with the impact of information technology on the environment, society and individuals. Encourage specific illustrations.

Resources & References

- Exploring Technology (Bergwall)
- Using The Computer In Industry, Illinois. Design A Mathematical Problem.
- CITE. Module CM-I-002. Types of Computer Logic.
- ITT: Technology Learning Activities, N.Y. Simulations and Modeling.
- Iowa Industrial Arts Handbook for Introductory Level: Production. "Figure It Out Yourself"
- CITE. Module CM-E-017. Creating Scripts for Radio Programs.
- CITE. Module CM-I-001. Fundamentals of Computer Software.
- Connections and other public television series dealing with the impact of technology.

Missouri

Introduction to Materials & Processing Technology

Unit 2: Technological Procedures

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

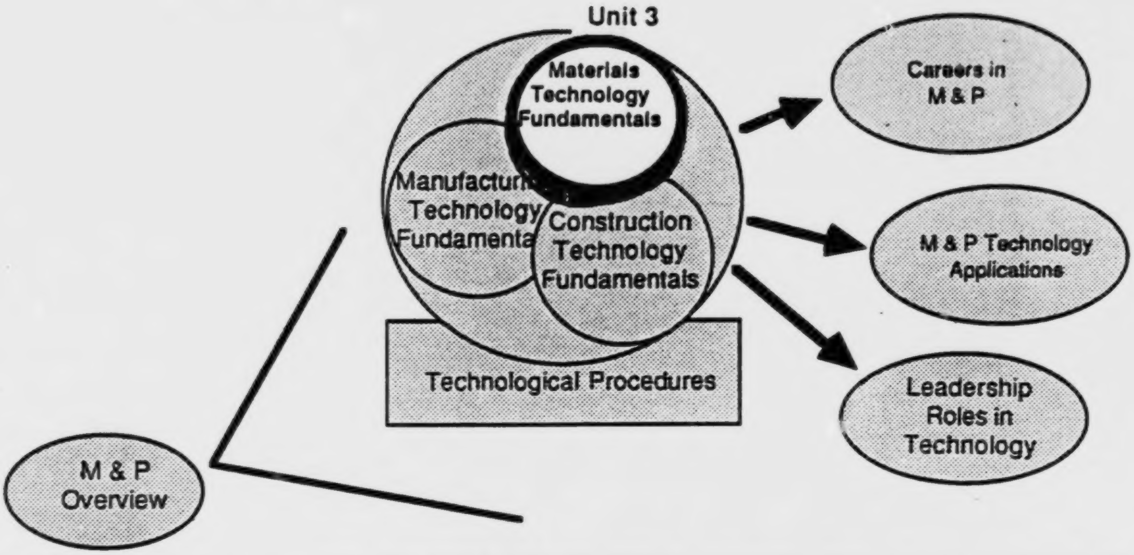
Advisory Group Input:

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 3: Materials Technology Fundamentals


Unit 3
Materials Technology Fundamentals
Manufacturi Technology Fundamenta
Construction Technology Fundamentals
Technological Procedures
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology
M & P Overview

The purpose of this unit is to examine the essential qualities and characteristics of a range of industrial materials including their classification, extraction, processing, testing, basic properties, safety and economic issues.

Unit Three: Materials Technology Fundamentals

OBJECTIVES: The purpose of this unit is to examine the essential qualities and characteristics of a range of industrial materials including classification, testing, basic properties, safety and economic issues.

COMPETENCIES -- The student will be able to:

1. Describe and give examples of categories of materials, properties and characteristics. (3,I)
2. Identify the range of materials in each major category; Organic, Metallic and Ceramic. (3,I)
3. Locate commercial data describing standard industrial stock in each category of material. (3,II)
4. Give examples of criteria used to specify materials in each of the major categories of materials. (3,II)
5. Provide some key examples of the relationship between the structure of materials and their properties. (3,III)
6. Describe the basic mechanical characteristics of materials in each major category of materials. (3,III)
7. Distinguish among torsional, impact, tensile and fatigue strength. (3,III,A)
8. Identify examples of material characteristics related to thermal, chemical, optical and electrical performance. (3,III,B)
9. Inspect materials and products using precision techniques. (3,IV)
10. Discuss the advantages and disadvantages of destructive and nondestructive testing. (3,IV)
11. Employ destructive methods to identify major characteristics and properties of materials. (3,IV,A)
12. Employ nondestructive methods to identify major characteristics and properties of materials. (3,IV,A)
13. Trace the flow of materials; (e.g., woods, iron, synthetics, glass) from their initial extraction/harvesting, through their processing into industrial standard stock, to the finished product. (3,V)
14. Describe standard industrial conditioning processes applied to materials, e.g., kiln drying, heat treating, preserving etc. (3,VI,D)
15. Secure and evaluate feedback to assess the effectiveness of a materials processing method. (3,VI)
16. Process a variety of appropriate metallic, plastic, ceramic and cellulose materials using separating, combining, forming and conditioning methods. (3,VI)
17. Employ important quality characteristics necessary for the informed purchase and use of selected materials in each major category. (3,VII)
18. Identify factors which affect material cost. (3,VII)
19. Provide examples of materials which have been used successfully in the miniaturization of components. (3,VII)
20. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. (3,VIII,C)
21. Explain the detrimental effects of radiation on the human body. (3,VIII)
22. Describe the general classifications of materials handling equipment. (3,IX D)
23. Identify and describe the equipment and materials used in materials testing. (3,IX,A)
24. Identify and describe a range of equipment used in materials extraction or harvest. (3,IX,E)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

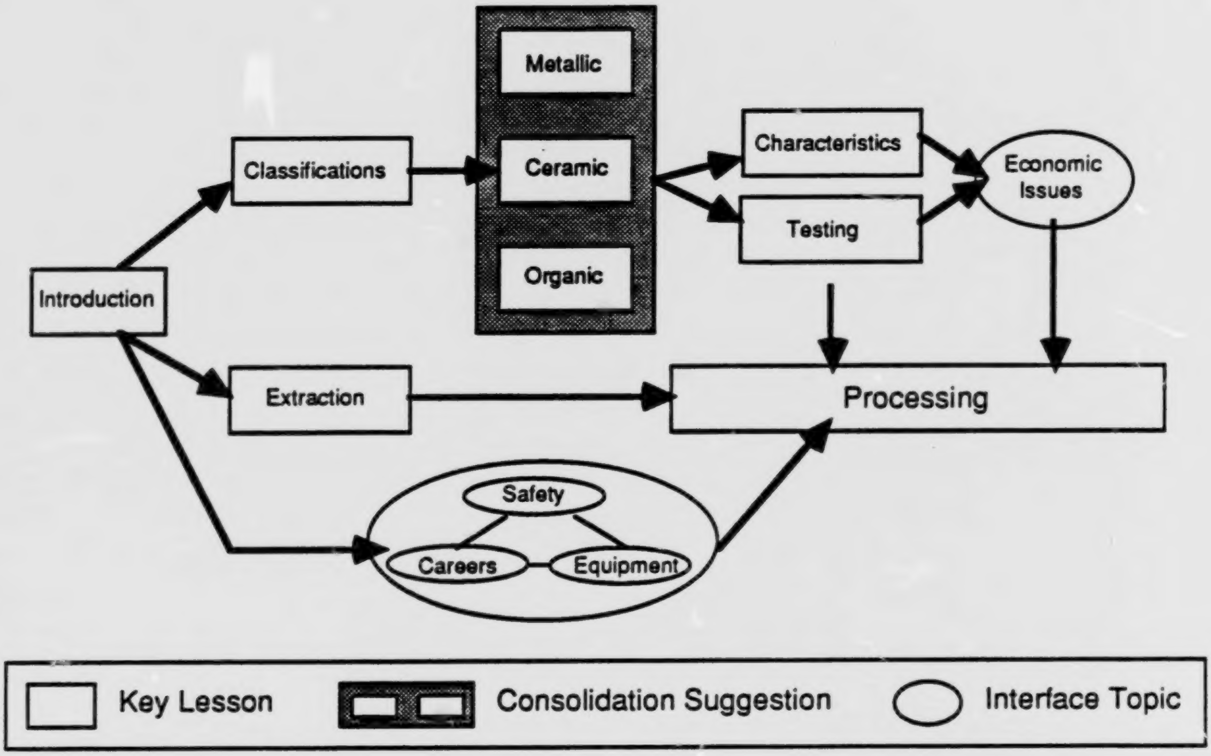
Content

I. Basic Classification of Materials
  A. Metallic
    1. Ferrous
    2. Non-ferrous
  B. Ceramic
    1. Raw Clays and Silicates
    2. Processed Clays and Silicates
      - structural clay products
      - white wares
      - refractories
      - glass
      - abrasives
      - concrete
  C. Organic
    1. Natural
      - Woods
      - Leather
      - Paper
      - Textiles

Teacher Plans & Activities

- Present and clarify the distinction between the basic materials classifications.
- Elicit student response in providing examples of materials in each classification.
- Show examples of each major category of material

Lesson/Activity Outline


Metallic
Introduction
Classifications
Ceramic
Characteristics
Economic Issues
Testing
Organic
Extraction
Processing
Safety
Careers
Equipment
Key Lesson
Consolidation Suggestion
Interface Topic

Student Activities

- Participate in a class trip to a steel mill, saw mill, recycling plant or any other extraction/harvesting venture.
- Identify testing, grading and materials classification systems used in an industry, e.g., a local lumber yard.

Resources & References

- Jacobs & Ritz (Fall 1981). Materials & processing technology: A foundation for technology education. Journal of Epsilon Pi Tau. p. 28-35.
- Ebert, S. (n.d.). Safety education handbook, Kansas State Department of Education. vol 1. pp. 238-239.
- Machinist's Handbook
- Superabrasive Kit (General Electric).
- NGA (1989). Glass & Glazing.
- Concrete & Concrete Masonry (IML 10-7151-S)
- Summit (1980). Wood.

Content

I. Basic Classification of Materials
  C. Organic, continued
    2. Synthetic
      - Fibers
      - Plastics
      - Rubber
      - Petroleum products
      - Paints
      - Explosives
      - Textiles

II. Materials Specifications
  A. Commercial Standards
  B. Standards Organizations
  C. Standard Stock

III. Materials Properties
  A. Mechanical Properties
    1. Strength
      - tensile
      - torsional
      - impact
    2. Hardness
    3. Ductility
    4. Malleability
  B. Materials Characteristics
    1. Thermal Properties
    2. Electrical Properties
    3. Chemical Reactivity
    4. Optical Properties

IV. Materials Testing
  A. Destructive vs. Nondestructive
    1. Destructive
      - impact
      - corrosion
      - bending
      - fatigue
      - shear
    2. Nondestructive
      - thermal conductivity
      - ultra-sound
      - X-Ray
      - electromagnetic resistance
  B. Static vs. Dynamic
  C. Low vs. High Temperature
  D. Field vs. Laboratory
  E. Testing vs Measurement vs Inspection

Teacher Plans & Activities

- Divide students into 3 groups with the task of providing specific examples of the uses of certain materials in industry (plastics, wood, rubber, etc.).
- Discuss the importance of the development of synthetic, ceramic and organic materials.

- Show samples of commercial standards, e.g., the American Iron & Steel Institute's or the Society of Automotive Engineers.
- Describe the operation of standards organizations, e.g., those establishing metric dimensions.
- Give examples of standard stock, e.g., structural steel, milled shapes, etc.

- Explain the basic components of materials science, exploring chemical bonding, crystalline structure, thermal conductivity, etc.
- Present the class with equally sized samples of wood, sheet metal, glass and paper. Conduct a vote of which is strongest. By what criteria? Use this as a lead-in to a discussion of basic mechanical properties considering such factors as tensile, torsional and impact strength; ductility, conductivity, etc.

- Have students conduct testing (weldment bending tests, liquid penetrant, magnaflux, etc.)
- Invite a welding X-ray tester to visit class. Show example X-rays which illustrate various defects.
- Invite students to provide examples of destructive and nondestructive testing techniques. It will be useful to focus on a broad range of industrial materials. Draw the analogy to testing of the human body.

Student Activities

- Make a bulletin board or display which illustrates the three basic materials classifications.
- Complete the glass making activity in Section II of this guide (TAM #3).
- Design and construct an etched glass product.
- Conduct a series of Rockwell hardness tests on a variety of materials.
- Visit a petroleum refinery and compare/contrast continuous flow to other types of production.
- Make ink, paper and silkscreen. Print a design.
- Make a fiberglass stereo speaker (TAM #4).
- Cast plastic products, e.g., fishing lures, ornaments, etc.
- Make photoemulsion film, a pinhole camera and take a picture.
- Conduct a weldment bend, liquid penetrant test and X-ray test.
- Make a truss to be tested with a strain gauge.
- Layout and etch printed circuit boards.
- Conduct a corrosion/exposure resistance test of sample finishes.
- Interview a person who works in one of the following industries: refinery, mine, testing lab, glass blowing shop, steel mill, brick plant.
- TAM #5: Nondestructive Testing.
- Visit local industry and secure available resources describing materials they use.

Resources & References

- Baird (1986). Industrial plastics.
- Fiberglass-reinforced plastics (IML 70-9300)
- Richardson (1987). Composites: A design guide.
- Plastics technology (IML 60-8007)
- World of plastics film (Modern Talking Pictures)
- Pollack (1981). Physical properties of materials for engineers.
- Using & Evaluating Materials (ETE video & inst. matls./IML)
- Ritz (1980). Materials and processes technology.
- Carmichael (1982). Handbook of physical properties of rocks.
- Kazanas, et al. (1986). Technology of Industrial materials.
- Developments in materials research. Research & Development. January 1988.
- Phelan (Sept/Oct 1986). Holography: A tool for nondestructive testing. Functional Photography. pps. 16, 18, 43.
- Article pertaining to materials testing, e.g., Dennis, J. A. Understanding and measuring moisture conditions in wood. School Shop. August 1987, p. 18-19

Content	**Teacher Plans & Activities**
V. Extraction/Harvest A. Raw Material Sources 1. Atmosphere 2. Marine 3. Earth 4. Living Organisms B. Extraction Methods 1. Chemical 2. Physical 3. Thermal 4. Electrical	• Select a variety of raw and processed materials (sandpaper, glass, brass, paint, etc). Ask students to identify the source of each material in its natural environment.
VI. Materials Processing Processes A. Separating Processes 1. Shearing 2. Chip removal 3. Sawing 4. Clearing B. Combining Processes 1. Fusing 2. Adhering 3. Coating 4. Bolting 5. Nailing C. Forming Processes 1. Spinning 2. Stamping 3. Casting D. Conditioning Processes 1. Tempering 2. Annealing 3. Shot peening	• Illustrate examples of each major category of materials processing processes.
VII. Economic Characteristics of Materials A. Specific Weight 1. Microminiaturization 2. Light-weight materials B. Corrosion Resistance C. Toxicity D. Availability E. Shelf Life and Storage	• Provide illustrations of economic considerations in the selection of materials for industry. Examples might include weight, durability, shelf life, storage costs, etc. • Lead a discussion regarding the appropriate matching of materials to specific industrial applications.
VIII. Safety A. Inherent Material Characteristics 1. Radioactivity 2. Electrical Conductivity 3. Toxicity B. Production 1. Heat exchange 2. Chemical by-products 3. Electrical discharge C. Work habits	• Ask students to identify specific hazards involved in the harvest and/or handling of industrial materials. • Show slides and catalogs of contemporary industrial equipment. Compare to laboratory equipment and stress the similarities.
IX. Equipment A. Testing Equipment B. Raw Material Processing Equipment C. Safety Equipment D. Handling Equipment E. Raw Material Extraction Equipment	

Student Activities

- Write a technical research paper on one of the following topics: The relationship of automobile weight to fuel efficiency, hazardous materials in the welding industry, space manufacturing, underwater construction techniques, etc.
- Evaluate two competing material processing methods in terms of their:
  - Labor requirements
  - Energy cost
  - Time demands
  - Reliability
  - Safety
- Produce individual or mass-produced projects employing materials processing techniques.
- Secure program advisory council resources for these topics.
- Complete a teacher-prepared worksheet on safe use and handling of materials.
- Build a materials testing machine, e.g., guided bend tester, hardness tester (schleroscope).

Resources & References

- NASA Tech Briefs
- Plastics fabrication (IML 80-2673)
- Modern Talking Pictures free loan films and video tapes.

Missouri

Introduction to Materials & Processing Technology

Unit 3: Materials Technology Fundamentals

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

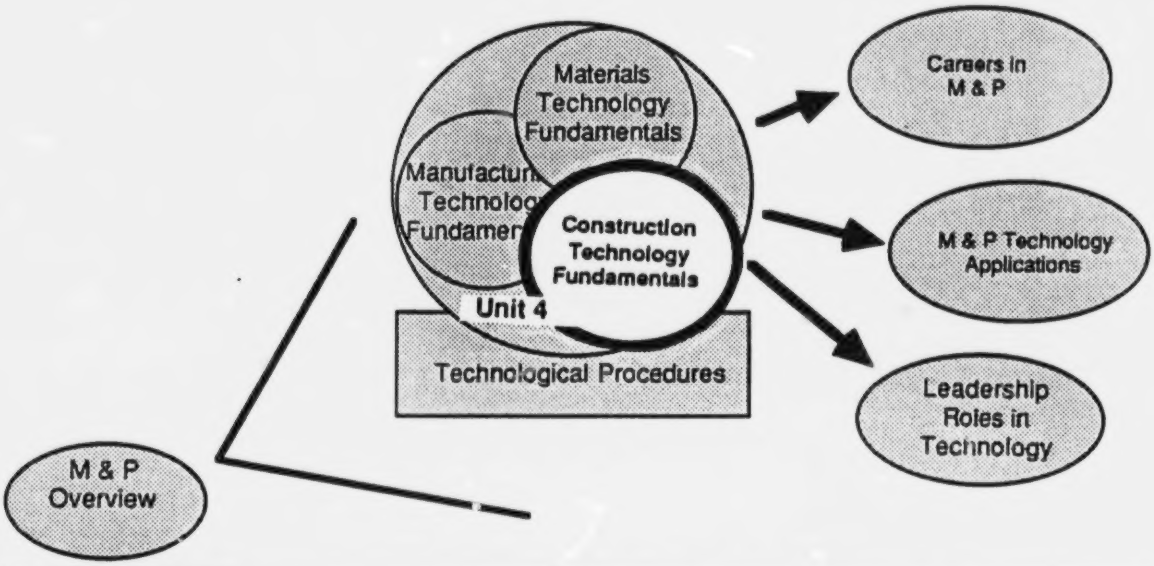
Advisory Group Input:

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 4: Construction Technology Fundamentals


Materials Technology Fundamentals
Manufacturing Technology Fundamentals
Construction Technology Fundamentals
Unit 4
Technological Procedures
M & P Overview
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology

The purpose of this unit is to explore the use of materials and processing technology as it applies to construction including design, procedures, tools, equipment, sales & legal issues related to buildings, structures and public works.

Unit Four: Construction Technology Fundamentals

OBJECTIVES: The purpose of this unit is to explore materials and processing technology in construction including design, procedures, tools, equipment, materials, sales and legal aspects of the technology and its applications.

COMPETENCIES -- The student will be able to:

1. Identify and describe the basic types of residential and commercial structures. (4,I)
2. Identify the basic types of construction. (4,II)
3. Differentiate between residential/commercial and light/heavy construction. (4,II)
4. Describe manufactured construction techniques. (4,II,D)
5. Demonstrate the safe use of equipment, supplies, materials and processes in construction technology. (4,III)
6. Incorporate safety and security measures into building designs. (4,III)
7. Apply the concepts of residential building design and technical drafting in producing a home design. (4,IV)
8. Identify structural and utility needs for light commercial buildings. (4,IV)
9. Use symbols, lettering and building standards as published by the American Institute of Architects. (4,IV)
10. Apply energy conservation practices in the design of structures and utility systems. (4,IV)
11. Design and schedule landscaping projects. (4,IV)
12. Plan, design, layout and build a scale model of a model community. (4,IV)
13. Use architectural drafting procedures to produce construction-related drawings such as floor plans, elevations, foundation plans, plot plans, wall sections and details. (4,IV,B)
14. Differentiate between the elements of custom detailing and modular construction. (4,V)
15. Identify light, heavy, industrial and civil construction processes and techniques including site preparation. (4,V)
16. Demonstrate basic construction knowledge and skills. (4,V)
17. Experiment with simulated foundations to identify their load bearing characteristics. (4,V)
18. Identify the major types of materials and supplies used in construction technology. (4,VI)
19. Identify and describe the essential features of the equipment used in construction technology. (4,VII)
20. Investigate and report on emerging tools, materials and processes in the construction industry. (4,VII)
21. Investigate the use of robots in manufactured construction techniques. (4,VII)
22. Estimate construction job costs and requirements. (4,VIII)
23. Describe the necessary characteristics of utility systems used in light construction. (4,IX)
24. Make sample utility (plumbing, electrical, climate control) installations on demonstrator installations. (4,IX)
25. Identify key factors related to security and site maintenance in construction technology. (4,X)
26. Analyze and explain the roles of management and labor as they relate to construction technology. (4,XI)
27. Participate in the planning, organizing, controlling, producing and quality control of construction processes. (4,XI)
28. Describe some key construction documents and legal requirements. (4,XII)
29. Discuss the methods of buying and selling real estate. (4,XIII)
30. Apply maintenance and servicing techniques to structures. (4,XIV)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

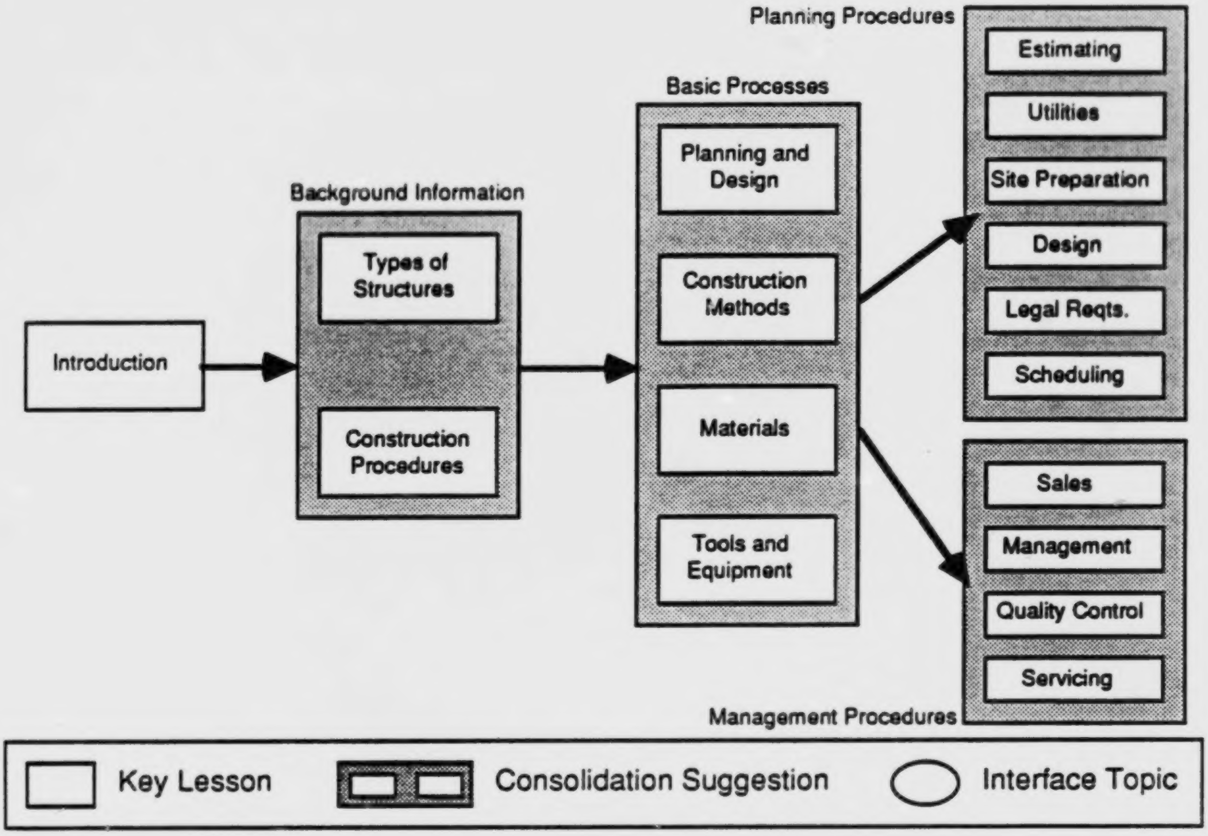
Content

I. Types of Structures
   A. Residential
      1. Homes
      2. Garages
   B. Commercial
      1. Sales
      2. Warehousing
      3. Transportation
      4. Farm
      5. Apartment
   C. Industrial
      1. Factory
      2. Workshop
      3. Construction site
   D. Public
      1. Bridges
      2. Roads
      3. Buildings
      4. Monuments

Teacher Plans & Activities

- Clarify and emphasize the importance of the distinctions among the types of construction.
- Develop a slide show depicting the variety of constructed structures.

Lesson/Activity Outline


Planning Procedures
Estimating
Utilities
Site Preparation
Design
Legal Reqts.
Scheduling
Basic Processes
Planning and Design
Construction Methods
Materials
Tools and Equipment
Background Information
Types of Structures
Construction Procedures
Introduction
Sales
Management
Quality Control
Servicing
Management Procedures
Key Lesson
Consolidation Suggestion
Interface Topic

Student Activities

- Make a video of structures in your community that you would identify as commercial and residential. Explain your classifications. Put the video to music that corresponds to the type of structure (e.g., heavy and loud for bulky, massive structures, light and brisk for graceful, light designs, etc.)

Resources & References

- The infra-structure - Kit (Missouri Association of General Contractors)
- Modern Talking Pictures
- Huth (1989). Construction Technology.
- Kicklighter (1984). Architecture, Residential Drawing and Design.
- Exploring Construction Technology (IML 60-2101)
- Introduction to Construction (ETE video & inst. matls./IML)

Content	Teacher Plans & Activities
II. Types of Construction Procedures A. Residential B. Commercial C. Modular D. Manufactured	• Describe the concept of manufactured housing. Present the advantages, disadvantages and unique qualities. • Illustrate the modular concept (brick, block, cabinet construction, unit developments, etc.) in construction with examples and/or slides.
III. Safety and Site Security A. Equipment B. Materials C. Design and Processes	• Outline the major safety hazards and considerations which are critical to construction technology.
IV. Construction Planning A. Project Needs Analysis B. Architectural Drawing & Design 1. Energy Conservation 2. Landscape Design C. Project Control Systems 1. Inspection 2. Permits D. Materials Procurement E. Scheduling F. Site Surveying	• Develop a series of humorous or perhaps tragic illustrations of lack of planning which illustrate the importance of planning in construction. • Define and outline key elements critical to good design e.g., proportion, aesthetics, function, texture, color, etc. • Illustrate the rationale for, and "hows" of, construction planning and control procedures. Give examples of PERT (program evaluation and review technique) and CPM (critical path method) approaches. • Obtain, share and explain samples of various construction permits
V. Construction Methods and Processes A. Modular Systems B. Sub-contracting C. Heavy D. Light	• Develop a bridge building and testing contest. • Introduce and explain the range of construction processes and methods, particularly those not common to the area or those not feasible to demonstrate in the laboratory. Include topics such as wall and roof framing, concrete work, electrical, plumbing, siding, insulation, finishing, etc. • Take the class on a field trip to a home which uses alternate forms of energy. • Arrange a field trip to a heavy construction site. • Invite a subcontractor to speak to the class about issues and procedures e.g., scheduling, billing, bidding, design, etc. • Discuss differences in construction methods related to various climatic conditions. • Involve students in a discussion of realistic quality and tolerance expectations in various phases of construction.

Student Activities

- Visit a sales showroom for pre-manufactured kitchen cabinets (typically in a lumber yard). Measure and inquire into the available widths. What factors become evident?
- Take a field trip to a manufactured home facility or a site where one is being assembled.
- Identify the advantages and disadvantages of the modular concept.
- Prepare a set of architectural plans for a residence. Include floor, plot, electrical, landscape and elevation plans.
- Design a safety and security program for a construction site.
- Participate in a field trip to the city or county inspector's office. Inquire into the kinds of codes, restrictions and laws that regulate construction in your community.
- Visit a construction site and view its building permits, plans being used and project control procedures.
- Use a transit, level and rod to establish a project's position, layout and dimensions.
- Develop a project schedule for a small construction project. Include projected dates for delivery of materials, inspections, sub-contractor work, etc. Prepare a PERT chart for project.
- Construct a frame structure (shed, garage, etc.).
- Design and build several types of trusses, test them and use your results to build a bridge for entry in the state contest (TAM #6: Bridge Construction).
- Make a scale model of a structure, e.g., roof including hip, gable and gambrel; a modular steel building, an office tower, a bridge, etc.
- Lay-up a small brick or block wall for a small structure or demonstration sample.
- Visit a truss building or concrete fabrication facility.
- Complete module CO-W-010, "Installing HVAC Systems" (CITE Activities).
- Build a multi-level city block design model on a table. Levels could represent a different system. (e.g., water, waste, electrical, landscape, etc.).
- TAM #7: Construction Projects.

Resources & References

- Concrete Institute
- American Institute of Architects' standards
- CITE Activity Series in construction
- Designing & Planning a structure (ETE video & inst. matls./IML)
- Basic Surveying Technology (IML 70-7692)
- Building Safely (ETE video & inst. matls./IML)
- Harms (1988). Construction technology activities.
- Landers (1983). Construction materials methods.
- Fierer & Hutchings (1986). Carpentry & building construction.
- Lux, et al. (1986). World of construction.
- Contact major modular home builders for promotional materials/videos.

Content	**Teacher Plans & Activities**
VI. Materials and Supplies A. Traditional Materials B. New and Emerging Materials 1. Synthetics 2. Composites 3. Recycled 4. Reconstituted	• Assign students the challenge of identifying examples of new and emerging construction materials. Reporting format could be individual presentations or group display. • Conduct a brainstorming session of possible new materials (or new applications of traditional materials) e.g., plastics in construction, glass for floors, etc. • Discuss the reasons why certain materials are used for conventional applications where others might be preferred. • Demonstrate a slump test. • Identify and discuss the marketing and distribution systems for materials related to construction technology.
VII. Tools and Equipment A. Heavy Equipment B. Light Equipment C. Emerging Equipment D. Hand Tools	• Walk students through the interpretation and use of information presented on framing square tables. • Present an illustrated overview depicting equipment and tools used in light and heavy construction. • Assign class members to research the process of obtaining cost-estimates for selected construction tools and equipment. • Discuss the safety implications of construction equipment use, maintenance and storage.
VIII. Estimating and Cost Analysis A. Materials Take-off B. Cost Estimating Procedures C. Purchasing/Selling Conventions D. Cost Reduction Considerations E. Types of Cost Estimates	• From a set of architectural plans, have a bidding contest. The winner is the one who comes closest to the actual contractor bid that was awarded the job. • Invite a contractor to speak to the class concerning the factors involved in the cost-estimating process. • Present the basic cost categories which must be addressed in cost-estimating. • Outline the various types of cost-estimating, e.g., cost plus, firm bid, time and materials, etc.
IX. Utilities A. Electrical B. Gas C. Sewage D. Water E. Ventilation F. Light G. Climate H. Security I. Communication	• Discuss the requirements, restrictions and regulations governing the installation and use of utility systems in your community. • Explain the functions of each of the major utility systems showing how they tie into larger systems (supply, generating, interrelated systems, etc.).

Student Activities

- Develop a listing of the contracting materials suppliers in your area and categorize it according to the common stages of construction.
- Research and write a technical paper on topic such as: "Why Wood in Home Construction?" or "Why Steel or Concrete...?"
- Visit with an experienced plumber or any other building trades person. Have that person explain the changes in materials and systems that have occurred over the past 10-20 years.
- Identify the greatest differences and similarities between materials used in residential and commercial construction.
- Build a concrete form and use it to produce a product such as a patio block, splash block, bicycle stand etc. (TAM #8: Concrete Processing).
- Make a laminated concrete form.
- Do a slump test on various concrete mixtures.
- Layout a hip, jack and common rafter using the framing square table. Assemble into a model roof corner.
- Visit a job site where framing or shingling is being done with air powered nailing equipment. Obtain an estimate of the time savings for the job compared to hammer and nail applications.
- Develop a complete materials list and itemized cost for a construction project including both materials and labor costs.
- Obtain estimates of annual costs associated with the major utilities for the home in which you live (water, electrical, gas, sewage, etc.) As a class try to identify the factors that account for differences in amounts in class member's homes.

Resources & References

- Engineering & Structures Module 14 (Synergistic Technology, PITSCO).
- For construction modeling supplies and information contact large hobby shops, model railroad publishers like Kalmbach Books, 1027 North Seventh Street, Milwaukee, WI 53233. Model railroad magazines list many useful catalogs.
- Concrete related materials are available from the National Concrete Masonry Association, P. O. Box 781, Herndon, VA 22070-0781.
- Obtain do it your-self tools, job and/or materials guide from local hardware/home centers.
- Infra-Structure Kit (Missouri Association of General Contractors).

Content	Teacher Plans & Activities
X. Site Preparation A. Design Factors B. Structural Considerations C. Clearing D. Problem Resolution E. Landscaping	• Research and present information related to unique site preparation factors for heavy construction applications, e.g., highways, Gateway Arch, Sears Tower, etc. Conduct field trip if possible. • Discuss residential site development factors, e.g., drainage, percolation, compaction, etc. • Provide examples of a variety of underdeveloped sites. Assign group the challenge of designing structure(s) which tastefully and creatively conform to existing landscaping features, contour, etc.
XI. Management, Quality and Labor Relations A. Unions B. Management -- Labor interactions C. Work Enhancement/Enlargement	• Present an analysis of the contents and purposes of a union - employer contract. • Explain the trend towards work enlargement/enhancement and give some examples, e.g., Volvo, Japanese industry, etc.
XII. Legal Documentation & Requirements A. Purchasing/Bidding B. Titles	• Have a lawyer explain key legal requirements related to construction.
XIII. Sales & Real Estate A. Financing B. Sales/Purchasing Methods	• Invite a real estate sales person to speak about contemporary sales, financing strategies, policies, etc.
XIV. Servicing & Maintenance of Structures A. Cleaning B. Repair/Maintenance C. Prevention	• Identify the necessary routine maintenance and cleaning services required for a family home and explain the effects of preventive activity.

Student Activities

- Produce a photographic display illustrating landscaping which represents quality design. Identify the key design factors in such work.
- As a class project, build a scale model subdivision complete with structures, landscaping, roads, lighting, etc. Organize into teams to simulate various contractors and their roles to parallel how a subdivision is actually developed.
- Analyze a series of real estate advertisements from various sources. Identify the methods they use to sell. Which work and which don't?
- Simulate and role play a labor - management negotiation session.
- Obtain and analyze samples of blank legal documents used in construction projects.
- Calculate a finance plan for a commercial project.
- Perform a preventative maintenance project on the family home, apartment or farm.

Resources & References

- Construction Technology, Utah. Construction of Tunnels.
- Construction Technology, Utah. Construction of Highway.
- Construction Technology, Utah. Construction of Bridge.
- Construction Technology, Utah. Construction of Waterway.
- Construction Technology, Utah. Construction of Sewer.
- CITE. Module CO-P-011. Developing Specifications for Wood-Frame Structures.
- CITE. Module CO-P-020. Making a Project Plan.
- CITE. Module CO-P-014. Site Analysis.
- CITE. Module CO-W-031. Producing Reinforced Concrete.
- CITE. Module CO-W-033. Installing Electrical Systems.
- CITE. Module CO-W-034. Installing Electrical Devices.
- CITE. Module CO-W-028. Constructing Structures: Electrical Wiring-Rough In.
- Technology Modules. West Virginia. Bridge Construction
- Technology Modules. West Virginia. Dream House.
- CITE. Module CO-W-043. Repairing Wall Damage.
- CITE. Module CO-W-004. Estimating Interior Repairs.
- CITE. Module CO-W-006. Estimating Exterior Repairs.
- AIT Finishing a Structure video (MVRC)

Missouri

Introduction to Materials & Processing Technology

Unit 4: Construction Technology Fundamentals

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

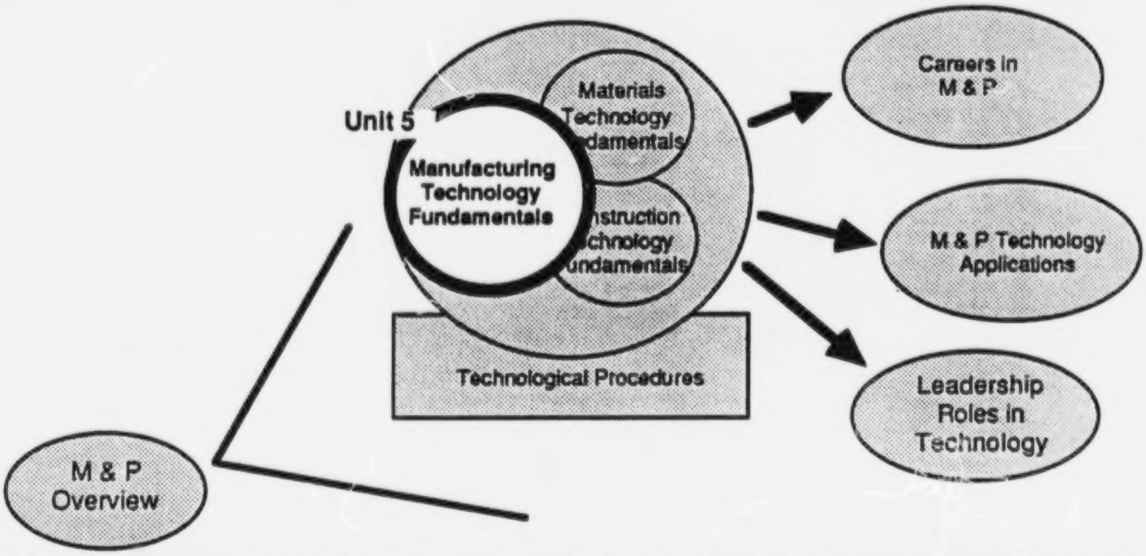
Advisory Group Input:

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 5: Manufacturing Technology Fundamentals


Unit 5
Manufacturing Technology Fundamentals
Materials Technology damentals
nstruction chnology undamentals
Technological Procedures
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology
M & P Overview

The purpose of this unit is to explore a range of topics within a manufacturing technology context. Topics include current practices and future trends in design, planning, jigs, fixtures, tooling, materials handling and production.

Unit Five: Manufacturing Technology Fundamentals

OBJECTIVES: The purpose of this unit is to explore the tools, materials and processes of manufacturing technology. Lessons will focus on both current practices and future trends.

COMPETENCIES -- The student will be able to:

1. Participate in establishing, financing, planning, organizing, controlling, producing and quality assuring of real or simulated mass production/manufacturing enterprises. (5,I)
2. Select and apply appropriate fasteners in products. (5,II)
3. Name and describe major types of adhesives, citing the properties of each. (5,II)
4. Describe various abrasives citing the characteristics of each. (5,II)
5. Describe and correctly apply various finishing materials, citing the advantages, disadvantages, characteristics and purposes of each. (5,II)
6. Prepare a complete bill of materials from a working drawing. (5,II)
7. Demonstrate and list the safe use of tools, equipment, materials and processes involved in production technology. (5,III)
8. Identify and describe the essential features of the equipment used in manufacturing technology. (5,IV)
9. Apply hand, mechanized and automated processes in the production of a product. (5,V)
10. Explain the industrial processes employed to separate, combine, condition, form and fabricate materials. (5,V)
11. Devise a plan of procedures and operations for repetitive and quantity fabrication of products or components. (5,VI)
12. Employ a systematic design process to produce a product that meets the assigned design specifications. (5,VI)
13. Read technical and working drawings and prints to secure needed information. (5,VI)
14. Describe the activities of a design department in manufacturing industries. (5,VI)
15. Solve simulated industrial design or planning problems in the production of a product. (5,VI)
16. Evaluate manufactured products in terms of appropriateness of material, function of design, effectiveness of purpose as well as quality of construction. (5,VI)
17. Describe and simulate the activities of a research and development department in bringing out a new product. (5,VI)
18. Use symbols, lettering & production standards as published by trade and government organizations. (5,VI)
19. Employ conventional drafting techniques to produce production drawings that meet appropriate standards. (5,VI,A)
20. Employ CAD techniques and equipment to produce drawings or other output that meets appropriate standards. (5,VI,A)
21. Estimate job production costs and requirements. (5,VI,B)
22. Identify and describe the key interrelationships between management, personnel, labor and production practices. (5,VII)
23. Sequence the key factors involved in securing financing for product development and manufacturing. (5,VIII)
24. Discuss issues related to the marketing and distribution of manufactured goods. (5,IX)
25. Analyze and explain the roles of management and labor as they relate to production technology. (5,X)
26. Contrast the factors involved in designing for service of a product after sales as contrasted to designing for its manufacture. (5,XI)
27. Investigate and analyze various material industries' impact on the ecological balance, the utilization and conservation of natural resources and the recycling of materials and goods. (5,XII)
28. Research and debate environmental problems and recycling technology as they relate to production technology. (5,XII)
29. Develop various scenarios for production technology breakthroughs and future trends in industry. (5,XIII)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

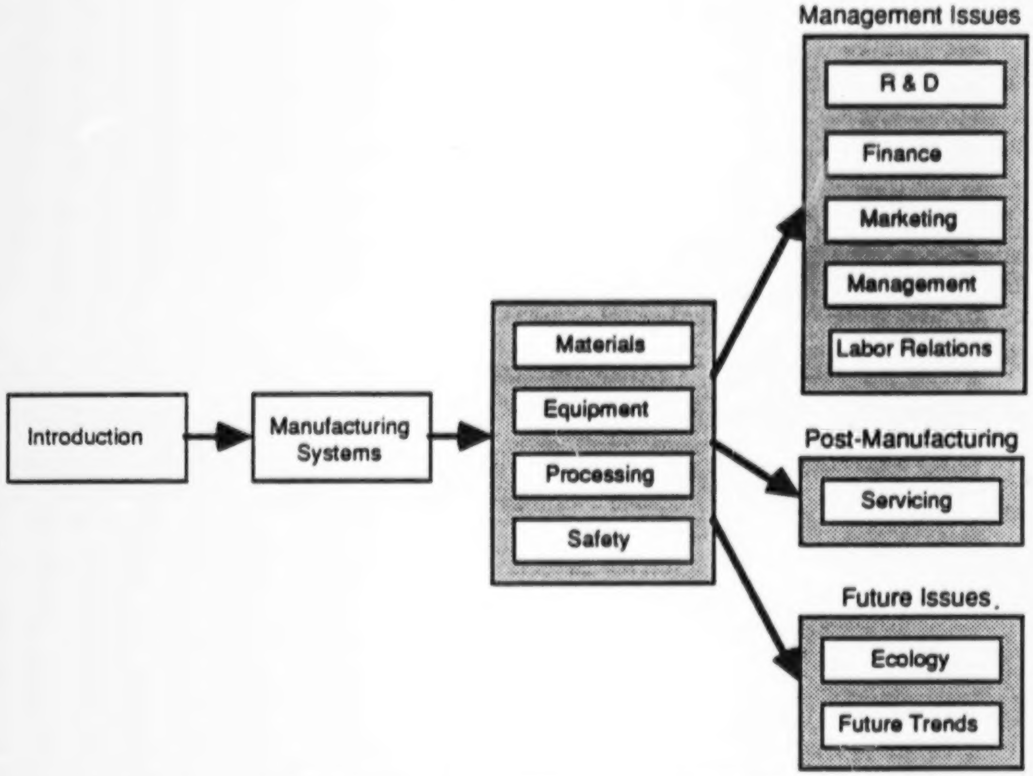
Content

I. Manufacturing Systems
  A. Mass Production
    1. Automobile (most existing)
    2. Newspapers
    3. Office furniture
  B. Craft
    1. Stained glass
    2. Serigraphs

Teacher Plans & Activities

- Characterize the basic differences between the types of manufacturing systems using local/regional examples.
- Trace the historical development of various manufacturing systems, e.g., Henry Ford's moving assembly line.
- Organize a debate over the advantages and disadvantages of mass vs. custom production.

Lesson/Activity Outline


Introduction
Manufacturing Systems
Materials
Equipment
Processing
Safety
Management Issues
R & D
Finance
Marketing
Management
Labor Relations
Post-Manufacturing
Servicing
Future Issues
Ecology
Future Trends

☐ Key Lesson ▨ Consolidation Suggestion ○ Interface Topic

Student Activities

- TAM #10: Automated Manufacturing.
- Research and write a report of Henry Ford's development of the moving assembly line or some other historical aspect of manufacturing.
- Participate in the organization and operation of a mass production activity, e.g., camp stools, desk/locker organizer, car speakers, etc. (TAM #12: Mass Production).

Resources & References

- Harms (1988). Manufacturing technology activities.
- Exploring manufacturing technology (IML 60-9104)
- CNC Simulator Computer Program (Hearlihy)
- Tver & Bolz (1983). Robotics sourcebook and dictionary.

Content

- C. Custom
  - 1. Special order vehicles
  - 2. Built -in furniture
  - 3. Dentures
- D. Automated
  - 1. Auto engine plants
  - 2. Consumer electronics

II. Materials and Supplies
- A. Planning
- B. Procurement Planning
- C. Specifications
- D. Quality Factors
- E. Economic Factors

Teacher Plans & Activities

- Outline the factors involved in selecting appropriate materials for manufacturing, e.g., weight, texture, strength, durability, etc.
- Conduct a brainstorming session on the types of materials used in manufacturing. After compiling the list, assign students to research the relative frequency of use, and reasons for, each material, e.g., availability, desirable characteristics, etc.
- Introduce students to the Machinist's Handbook, the Plastics Encyclopedia, and/or equivalent resources.
- Describe the various methods by which materials are specified (lumber grades, steel carbon content and alloy designations, etc.).
- Discuss the factors that render a material economical for manufacturing use, e.g., ease of extraction and development, relative abundance, etc.
- Present and explore new and emerging materials for manufacturing.

III. Safety in Manufacturing
- A. Government Regulations & Organizations
- B. Industry Standards
- C. Personal Protective Equipment
- D. Laboratory Procedures
- E. Prevention

IV. Tools, Machines, & Equipment
- A. Separating Tools, Machines & Equipment
  - 1. Hand
  - 2. Power
  - 3. Machine
- B. Combining Tools, Machines & Equipment
  - 1. Hand
  - 2. Power
  - 3. Machine
- C. Forming Tools, Machines & Equipment
  - 1. Hand
  - 2. Power
  - 3. Machine
- D. Conditioning Tools, Machines & Equipment
  - 1. Hand
  - 2. Power
  - 3. Machine

- Demonstrate how to conduct a job safety analysis.
- Present key safety requirements for work in the laboratory and evaluate their mastery.
- Illustrate high technology production equipment used in manufacturing, e.g., CNC, Robotics, turret lathes, pressure molding equipment, semiconductor fabrication, etc., using trade journals and available media.
- Categorize the various machines and tools used in manufacturing, e.g., materials handling, materials processing, assembling, jig and fixturing, measurement and testing, etc., according to their basic function and/or purpose. Show how these industry-based classifications apply to school laboratory equipment used by students in their project work, e.g., building electronic dice, fishing lures, welding, etc.

Student Activities

- Visit a custom production shop (welding, cabinet, etc.) and a mass production plant. Contrast and compare the two methods in terms of product quality, efficiency, employee morale, organization, equipment, etc. Present your observations to the class.
- Observe casting processes in a local dentist's or orthodontist's office.
- Produce a working/engineering drawing for a part to be produced. Present a rationale for the materials specified as well as their cost and supplier information.
- Consult the Thomas Register or other industrial references to locate materials suppliers appropriate to the class production product.
- Evaluate manufactured products supplied by your instructor. Include assessments of the overall quality of product, appropriateness of materials for that product, quality of the material, quality of design, etc.
- Organize a ball point pen reassembly activity to illustrate uniformity of parts.
- Compare safety procedures employed in the laboratory to those of industry.
- Conduct safety audit of the school's ITE laboratory or of a specific machine/process.
- Program a CNC trainer.
- Design & produce a sandcast product in a foundry.
- Participate in a field trip to a highly mechanized factory. (Auto assembly plant, appliance production facility, modular home plant, etc.)
- Make an item using machines, e.g., engine lathe, vertical mill, surface grinder, drill press, etc. Prepare an outline of the processes involved and then a list of machines, complete with pictures, which could be used for each process in a high production setting.
- For a specific process and machine, make an economic decision as to what level of production is necessary to justify the purchase of a high production, computer-controlled machine. Include realistic volume and machine costs estimates.
- Complete TAM #9: Jigs and Fixtures.
- Build a simulated production cell using Fisher/Lego Technic or equivalent modeling kits.
- TAM #11: Robotics.

Resources & References

- Fisher technik newsletter
- Lego technic manuals
- Goetsch (1989). The CAD/CAM workbook.
- Robotics software series, kits and model (Hearlihy)
- Robotics automation module 11 (Synergistic Technology, PITSCO)
- Nelson & Selvidge (1986). The manufacturing enterprise.
- Johnson (1988). Metals technology - CNC lathe
- Moltrecht (1981). Machine shop practice.
- Henriksen (1973). Jig and fixture design manual.
- Olivo (1987). Machine tool technology & manufacturing processes.
- Wright (1987). Processes of manufacturing.
- Wright (May 1987). Making jigs & fixtures teaching tools. Industrial Education. pps. 29-43
- Scan safety resources in Section III, part 1 of this guide.
- Local safety councils
- Dyrenfurth & Linhardt (1981). Vocational Safety Guide.

Content

- V. Processing
  - A. Separating
    - 1. Shearing
    - 2. Chip removal
    - 3. Burning
  - B. Combining
    - 1. Welding
    - 2. Bolting
    - 3. Gluing
    - 4. Nailing
    - 5. Plating
  - C. Forming
    - 1. Casting
    - 2. Spinning
    - 3. Bending
    - 4. Stamping
    - 5. Forging
  - D. Conditioning
    - 1. Tempering
    - 2. Stress relieving
    - 3. Tensioning
- VI. Research and Development
  - A. Problem Solving
  - B. Design and Planning
  - C. Cost Analysis
  - D. Testing
  - E. Types
    - 1. Basic
    - 2. Applied
- VII. Management
  - A. Employment
  - B. Plant Layout
  - C. Organizational Systems
  - D. Decision-making Principles
- VIII. Financing/Enterprise
  - A. Capital
  - B. Financing Principles
  - C. Cost Analysis

Teacher Plans & Activities

- Highlight safety control devices used in production manufacturing settings, e.g., dual hand controls, safety guards, noise protection, etc.
- Develop a class project, e.g., building an acorn table that can be used in subsequent mass production activities.
- Outline, illustrate and distinguish among the various processing methods. Give examples of each and demonstrate where feasible.
- Present selected parts or assemblies to small groups for evaluation. Have groups develop a sequential listing of processes performed to produce the part. (Select parts/assemblies which represent a diversity of processing methods.)
- Emphasize and highlight the categories of processes involved, e.g., separating, combining, forming, conditioning, etc., for activities in the "Student Activity" column.
- Point out the essential factors of design, e.g., proportion, economics, structural qualities, aesthetics, function, etc., as they apply to research and development.
- Describe the key steps of problem solving in the research and development process.
- Differentiate between the two major classifications of materials testing, e.g., destructive and non-destructive, and point out local/regional examples.
- Bring a plant manager to class and have him/her describe their plant's organization, operation and human resources.
- Role play job interview situations. Videotape the sessions and evaluate the results.
- Prepare a worksheet leading the students through a sample economic feasibility study for a proposed part or assembly.
- Invite a banker familiar with small businesses to speak to the class. Focus on issues related to obtaining capital, interest, manufacturing proposals that appear sound to the banking community, analyses employed, etc.
- Organize the class into two competing start-up enterprises and have each team secure the financing needed to begin production. Incorporate consideration of time cards, hiring, work records, billing, costing, pricing, etc.

Student Activities

- Make glass (TAM #3). Design and fabricate a product using manufactured glass, e.g., a leaded glass panel for a furniture door, a picture holder, aquarium, etc.
- Make ink, paper and silk screen. Print a design.
- Produce a fiberglass stereo speaker enclosure (TAM #4).
- Evaluate a manufactured product, supplied by your instructor, for design quality. Focus on criteria such as: material appropriateness, quality, proportion, function, appearance, etc.
- Visit a research and development department of a manufacturing firm. Look to identify the process that occurs when translating a product idea into a manufactured item.
- Complete TAM #5 on non-destructive testing.
- Conduct an analysis of the equipment layout of a lab in your school. How would you change it to make it work better?
- Estimate the amount of capital that would be required to start a small business.
- Establish the start-up finances for your mass production company.
- Explore the available resources and activities of Junior Achievement.

Resources & References

- JETS resources
- Henriksen (1973). Jig & fixtures design manual.
- Screwdriver (forging), Candle (HERF), or 4-in-a-row (Plastic Molding)units (Parke System)
- Manufacturing Process (ETE video & inst. matls./IML)
- Odyssey of the Mind books (MVRC)
- Kennedy, et al. (1987). Inspection and gaging.
- Diversified Technology (n.d.). Running Your Own Business Module
- Diversified Technology (n.d.). Managing Time & Resources Module
- Manufacturing Process Planning (ETE video & inst. matls./IML)
- Management core curriculum (IML 80-1044)
- Chamber of Commerce, Junior Achievement manuals
- PACE: Entrepreneurship Modules, level I (Center for Education & Training for Employment)
- MVRC Marketing Education resources
- Entrepreneurship core curriculum (IML 80-1039)

Content	Teacher Plans & Activities
IX. Marketing A. Product Demand Analysis B. Marketing Strategies C. Sales Systems 1. Retailing 2. Wholesaling 3. Direct Marketing 4. Referral	• Present key elements of marketing manufactured products. Interact with the school's marketing education teachers/classes to reinforce key points. • Analyze several notable historical failures or successes which have occurred in the manufacturing industry. Have groups identify what went right/wrong related to marketing, sales strategy, demand analysis, design, etc. (Examples could include the Edsel, Corvette, mini-skirt, compact disc, micro-computer, etc.)
X. Labor Relations A. Trade Unions B. Labor - Management interaction C. Labor - Related legislation	• Set up a debate regarding the advantages and disadvantages of trade unions. • Invite a union representative to present the case for unions to the class. • Secure examples of locally/regionally applicable labor legislation, e.g., "right to work" and explain its implications.
XI. Post-processing/servicing A. Service Systems B. Customer Feedback Systems C. Service Center Networking	• Analyze/discuss student attitudes about, and experience with, product service. • Discuss how customer feedback systems operate. Have students share experiences, good and bad, that they have had or are aware of. • Develop a service activity employing materials and processing technology, e.g., lawn mower, chainsaw, or other tune-up or repair; furniture repair, refinishing, etc. Keep track of costs, needed tools and essential equipment. Develop a system for billing parts and labor including forms. Include discussions of strategies, advertising, etc.
XII. Ecology A. Conservation of Resources B. Recycling	• Tour a local recycling operation and guide students through a cost-benefit analysis of it.
XIII. Future Trends A. Manufacturing Processes B. Equipment C. Production Systems D. Design E. Material Usage patterns	• Depict a scenario of the manufacturing plant in the year 2050, e.g., levitation devices, "beaming up" materials, instant microminiaturization, humanless factories, friction-free cutters, etc.

Student Activities

- Conduct a demand analysis for a product that you could produce in a mass production activity.
- Develop a listing of strategies or factors that work in effective sales, e.g., urgency, desire, power, money, etc.
- Simulate a work-related grievance procedure.
- Organize a student organization modelled after a union and focus on employee development programs.
- Dignity in the Workplace (Center for Education & Training for Employment) Student & Instructor Guides
- Organize and manage a service operation at your school, e.g., locker cleaning service, lease of a constructed locker organizer, etc.
- Have students write a letter to a company about a product they own which has broken or failed. (The challenge of the activity could be to see who hears back from the company and how effectively the students feel that the complaint was dealt with.)
- Compile a list of problems that make recycling difficult and apply technological problem solving to the problem.
- Prioritize local conservation needs with respect to materials and processing technology.
- Make paper from recycled materials, e.g., paper, cloth, cellulose.
- Analyze TV, videos, science fiction books, etc., for new trends in technology. Bring examples and ideas to share with the class.

Resources & References

- AFL-CIO labor education newsletter.
- Local unions
- Diaz (1982). Resource recovery from municipal solid wastes.
- Naisbett. Megatrends.
- Trade journals from various associations. See Section III, part 2.
- Hunt (1983). Industrial robotics handbook.
- Manufacturing Systems Explained (Bergwall)
- Foxfire books
- Appropriate technology books

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Introduction to Materials & Processing Technology

Unit 5: Manufacturing Technology Fundamentals

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

Advisory Group Input:

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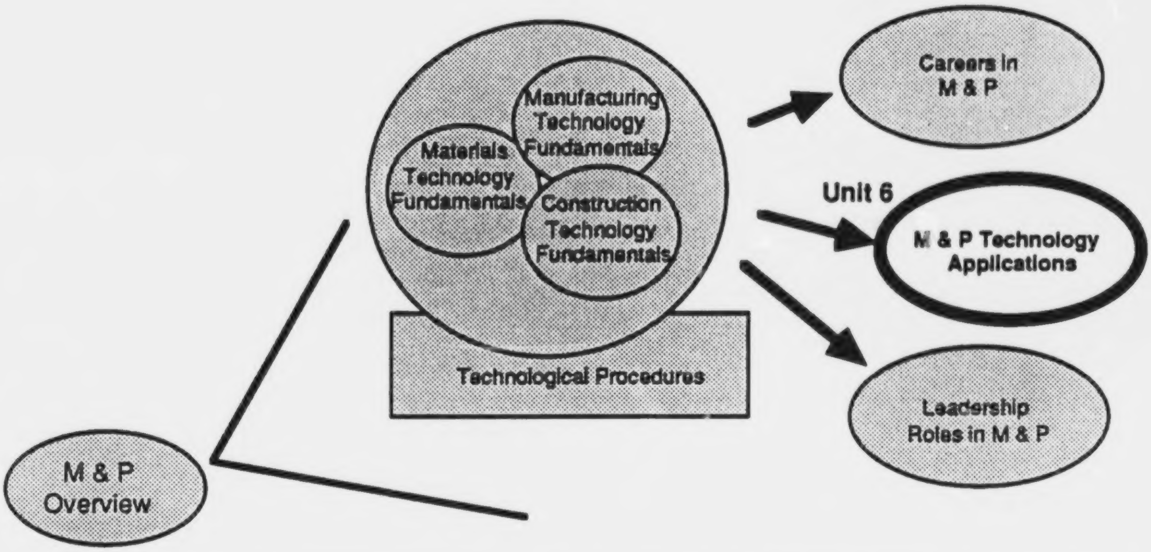
Introduction to Materials & Processing Technology

Instructor Guide

Unit 6: Materials & Processing Technology Applications


Manufacturing Technology Fundamentals
Materials Technology Fundamentals
Construction Technology Fundamentals
Technological Procedures
M & P Overview
Careers in M & P
Unit 6
M & P Technology Applications
Leadership Roles in M & P

The purpose of this unit is to integrate information and issues presented in the technological process, materials, construction and manufacturing units. The emphasis is on the systematic application of technology.

Unit Six: Materials & Processing Technology Applications

OBJECTIVES: The purpose of this unit is to integrate information and issues presented in the previous units. The emphasis of this unit is on the application of design and problem solving skills to the operation of a comprehensive materials and processing technology experience.

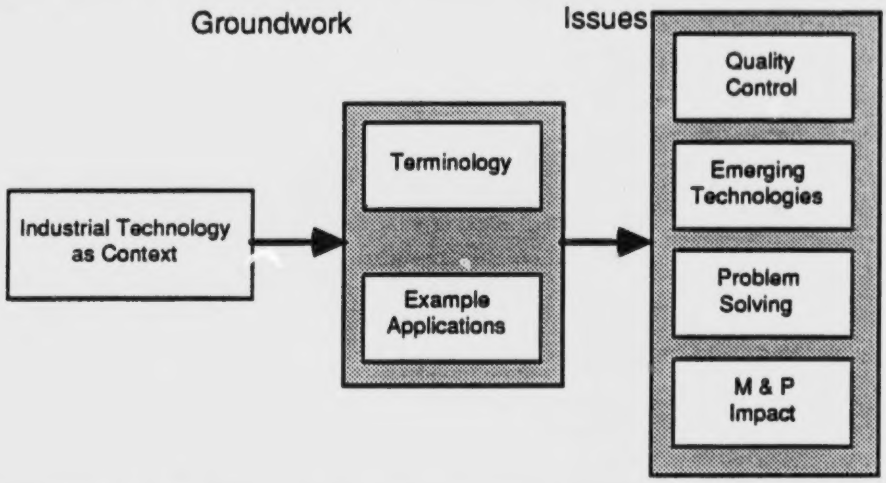
COMPETENCIES -- The student will be able to:

1. Place manufacturing and construction technology in the larger context of industrial technology. (6,I)
2. Explain the fundamental characteristics, roles, structure and organization of the manufacturing and construction industry. (6,I)
3. Define terms associated with selected high technology materials & processing technology like CAM, composites, holography and magnetic bubbles. (6,II)
4. Explain the steps and technology involved in major applications of materials & processing technology. (6,III)
5. Apply standard industrial quality control procedures to items produced in the laboratory or constructed on site. (6,IV)
6. Solve materials & processing technology problems through problem solving, creative thinking and decision making processes. (6,V)
7. Give examples of the positive and negative impacts of materials & processing technology. (6,VI)
8. Demonstrate the safe use of equipment, tools, materials and processes that are related to comprehensive applications of materials & processing technology. (6,III)
9. Apply maintenance and servicing techniques to goods and structures. (6,III)
10. Relate the activities of manufacturing and construction technology to local, state and national developments. (6,VI)
11. Experiment with processes, equipment and materials to develop insight into new and advancing technologies. (6,VII)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

Content	Teacher Plans & Activities
I. Context of Materials & Processing Technology A. Industrial Technology 1. Materials & Processing Technology 2. Energy & Power Technology 3. Communication Technology B. Technology (overall) 1. Military 2. Medical 3. Agricultural 4. Industrial	• Start student input discussion about how industrial technology is different from technology in general. What technologies (if any) do not apply to industrial technologies? • Explain how manufacturing and construction are primary components of industrial technology and how industrial technology is but one component of technology. Describe the systems approach.
II. Terminology A. Types of Terms 1. Jargon 2. Trade/Technology specific 3. Vernacular (every day) 4. Organizational B. Historical Terms C. Conventional Terms D. Emerging Terms	
III. Example Applications of Materials & Processing Technology A. Residential Construction B. Mass Production C. Craft Production D. Servicing	• Demonstrate key processes and safety procedures for typical production and construction activities.

Lesson/Activity Outline



☐ Key Lesson ▣ Consolidation Suggestion ◯ Interface Topic

Student Activities

- Make an organizational chart which shows how construction and manufacturing technology fit into technology. Include how they relate to other phases of industrial technology.
- Build a small building and sell it to the community.
- Design and mass produce a product using the problem solving process in all stages.
- Design and build doll houses for Christmas. Develop an extensive marketing plan.
- Participate in a major mass production activity. The challenge of this unit will be to solve a variety of problems encountered in the construction and manufacturing of materials.
- Make a wooden pipe rack to sell.
- Hold a Technology Bee for student teams or individuals competing for accuracy in defining/describing technological terms/processes.
- TAM #12: Mass Production.
- TAM #13: Forming and Managing a Company.
- Plan and operate an appliance (or lawn mower, etc.) service enterprise as moneymaker for the student association.

Resources & References

- Odyssey of the Mind resources (MVRC)
- SME resources & video, e.g., The Challenge of Manufacturing, Just In Time, etc.
- Mass production (Note Tray Unit, Parke System)
- Activity modules, various (PITSCO)
- Making the Macintosh (Apple Computer)
- Operation Leather; computer program-accounting, letters, sales reports, inventory, customer tracking (Tandy)

Content	Teacher Plans & Activities
IV. Quality Control A. Inspection B. Statistical Process Control C. Testing D. Measurement	• Specific instruction for appropriate aspects of quality control and statistical process control should be designed into all activities. For example, the production process, e.g., gauges, jigs, fixtures, data sampling, recording and analysis should be described. All measurements need to be double checked. The same measuring instruments should be employed. Quality should be sampled at regular intervals.
V. Problem Solving in Technology A. Identify Problem 1. Analyze problem 2. Analyze the problem's context 3. Define & clarify the problem B. Establish Solution Criteria 1. Identify appropriate criteria 2. Identify constraints and limitations 3. Weight criteria according to the nature of the problem 4. Develop a design brief C. Assemble Pertinent Information 1. Search for information 2. Analyze information 3. Synthesize appropriate information D. Formulate Alternative Solutions 1. Brainstorming 2. Remove barriers to creative juices E. Evaluate Alternatives 1. Apply solution criteria 2. Select optimum solution F. Implement Prototype Solution 1. Develop prototype solution - Produce drawings - Theoretical testing 2. Plan implementation of solution 3. Implement prototype solution 4. Evaluate prototype solution in operation G. Refine Solution 1. Communicate the solution 2. Refine the prototype solution 3. Implement the refined solution 4. Monitor the solution on an appropriate basis	• Demonstrate how the problem-solving process, including each of its sub-steps, operates and applies to the mass production activity being conducted by the students. • Develop a comprehensive mass production activity. This unit is intended to pull together information and concepts learned in the other units. It is very important that this activity emphasize the design and problem solving components during every phase of organization and implementation. Consider limiting instructional input to establishing parameters and then facilitating and stimulating the students' problem solving and creative processes. Even a failed activity can be an effective instructional tool. At appropriate points incorporate discussion and problem solving related to each of the content areas for this unit. (Possible projects include a small foam bass boat, doll houses, belt buckles, dog houses, models, etc.) • Organize a mass production enterprise that involves several schools to simulate a large enterprise.

Student Activities

- Analyze a local construction or manufacturing process and identify how quality could be improved.
- Develop manufacturing/construction application to solve a local civic problem.
- Conduct a contest to identify the best and worst manufactured/constructed items within 5 miles of the school.
- Establish a set of standards for chair comfort.
- Operate a mass production company.
- Organize and operate a building maintenance and problem solving service.
- Work across several schools on a community service project, e.g., building bus shelters, etc.

Resources & References

- Kennedy (1987). Inspections and gaging.
- Enrick (1985). Quality, reliability & process improvement.
- Diversified Technology (n.d.). Quality control and workgroups module.
- Enrick & Mottley (1983). Manufacturing analysis for productivity and quality/cost enhancement.
- Karger & Hancock (1982). Advanced work measurement.
- The Search for Solutions (video programs, Phillips Petroleum)
- Dietz, et al. (1989). Multi School Entrepreneurship & Manufacturing Unit for Technology Education.
- Statistical Process Control (IML 70-9501)
- Prototypes of manufacturing systems may be assembled using Polymek components (Unilab)
- People Technology & the Environment (ETE video & inst. matls./IML)

Content	Teacher Plans & Activities
VI. Impact of Materials and Processing Technology A. Environmental 1. Pollution 2. Control of floods 3. Balance of species B. Cultural 1. Mass communication 2. Approach/avoidance C. Individual 1. Consumerism 2. Wastefulness 3. High expectations 4. Throw-away society 5. More products	• Prepare a bulletin board or display showing impacts for each major technology from various perspectives. Have students discuss, analyze, and recommend additional perspectives/positions.
VII. Emerging Technologies & Materials A. Biotechnology B. Optical semi-conductors C. Memory materials D. Space manufacturing	• Collect newspaper/periodical articles about new developments in technology. Imagine that students are at two or three points in history. Have them speculate about what technology is available to them. What was its application? How did people react to that technology? What were their needs and priorities? • Have a student disassemble a product, e.g., a door lock, sketch the parts and then write reassembly directions. Then have other students follow these directions and rate the effectiveness of the directions. Have students analyze any problems that occur.

Student Activities	Resources & References
• Do an analysis of the costs and benefits of the most recent community development project. • Photo-document the school's student behavior that show disregard for the environment and efficient use of materials.	• Appropriate technology resources
• Develop a tree timeline by labeling the rings of a tree to mark technological achievements. • Contact NASA, the Pentagon, or other cutting-edge resource agencies and prepare a trend analysis of imminent developments in a selected materials or process area.	• O'Leary (1982). Space industrialization. • Curriculum for 2000 (SME)

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Introduction to Materials & Processing Technology

Unit 6: Materials & Processing Technology Applications

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

Advisory Group Input:

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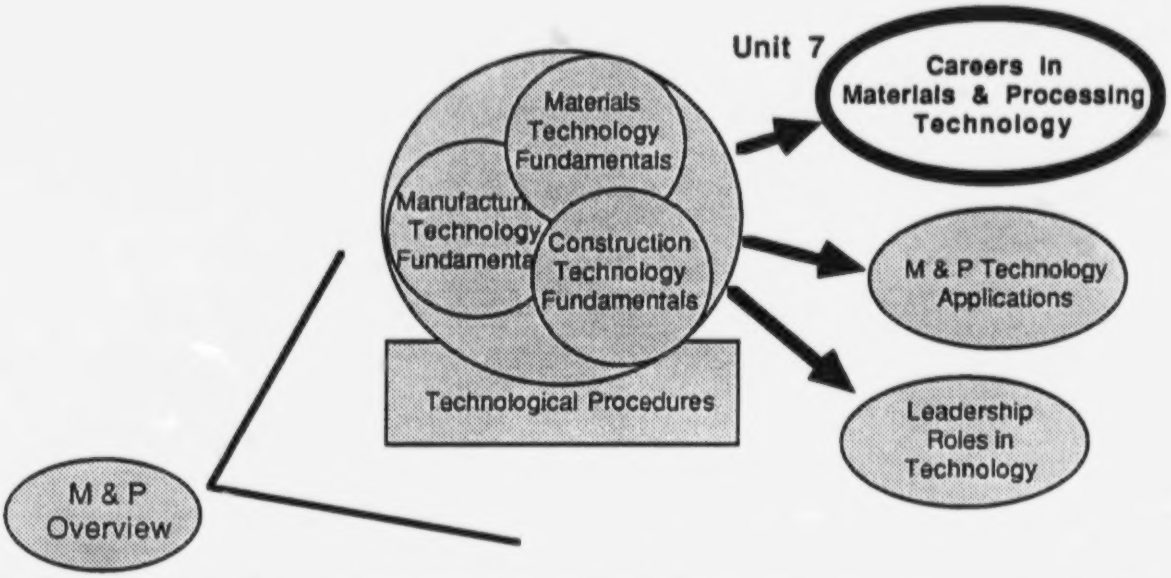
Unit 7: Careers in Materials & Processing Technology


Unit 7
Careers in Materials & Processing Technology
Materials Technology Fundamentals
Manufacturing Technology Fundamentals
Construction Technology Fundamentals
Technological Procedures
M & P Technology Applications
Leadership Roles in Technology
M & P Overview

The purpose of this unit is to examine a range of issues related to careers in materials and processing related technology including skills, training, trends and opportunities.

Unit Seven: Careers in Materials & Processing Technology

OBJECTIVES: The purpose of this unit is to examine a range of topics related to materials and processing technology careers, including personal characteristics and their relationship to required skills, training, trends and opportunities.

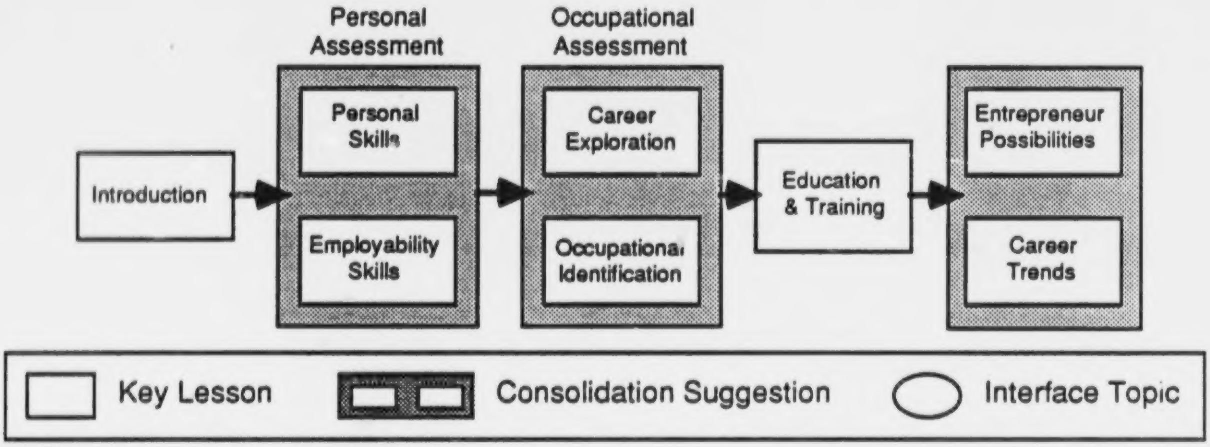
COMPETENCIES -- The student will be able to:

1. Demonstrate informed and meaningful occupational and educational choices. (7,I)
2. Explore career choices in engineering and related technological areas. (7,I)
3. Assess his/her personal characteristics, talents and interests as they relate to a career in materials & processing technology. (7,II,A)
4. Demonstrate appropriate employability skills in job identification, seeking and application. (7,A)
5. Demonstrate personal characteristics, interpersonal relations, dependability, work attitude, communication ability and personal hygiene/grooming appropriate to employability. (7,III,B)
6. Express a positive self-concept and attitude regarding equipment, productive effort and safety for him/herself and others. (7,III,B)
7. Differentiate among various career roles, levels and functions in materials & processing technology. (7,IV)
8. Identify and classify occupations in the materials & processing technology industry. (7,IV)
9. Identify, research and describe career and technological trends in materials & processing technology. (7,V)
10. Identify preparatory routes, levels of education and programs that lead to tentative career choices in technology. (7,VI)
11. Describe the potential for entrepreneurial activity in materials & processing technology. (7,VII)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

Content	Teacher Plans & Activities
I. Career Development A. The Process' Stages 1. Awareness 2. Exploration 3. Preparation 4. Updating B. The Content 1. Personal characteristics 2. Technological trends 3. Industry trends 4. Local/Regional trends 5. Educational preparation	• Incorporate career exploration information at appropriate points throughout the entire course of materials and processing study. • Bring guidance counselor to class to explain the career development process and the school resources available to help students, e.g., MO-View, SIGI-Plus. • Arrange for students to gain initial on-the-job experience in occupations of interest. • Be alert for opportunities that could expose individual students to career possibilities (seek to expand the range of possibilities and opportunities that they see for themselves). • Have program advisory council members conduct a session outlining the kinds of opportunities available in the materials and processing technology related areas.
II. Personal Assessment A. Personal Skills B. Potential Skills C. Personal Interests D. Personal Aptitudes	• Arrange for students to take the Strong Vocational Interest Inventory (or similar interest assessment tool). • Identify, confirm and discuss skills and potential skills that you see in individual students with those students. • Analyze needs vs. hourly salary, e.g., budget, money, savings, training, etc. • Set up a job clearinghouse for materials & processing technology related part-time and summer jobs.

Lesson/Activity Outline


Personal Assessment
Occupational Assessment
Introduction
Personal Skills
Employability Skills
Career Exploration
Occupational Identification
Education & Training
Entrepreneur Possibilities
Career Trends
Key Lesson
Consolidation Suggestion
Interface Topic

Student Activities

- Visit with a person who is in a vocation which is of interest to you. Find out what the job is like including skills needed, preparation necessary, etc.
- Do a case study/observation comparing the training, opportunities, salaries and working conditions of trade, technical and professional jobs within the same occupational clusters.
- Identify some skills that you would like to develop. Check newspaper advertisements for job training requirements, skills, goals, rewards, etc.
- Compare the training/working conditions of your grandparents, parents and today. Similarly compare and discuss the technology of the past with that of the present and the future.
- Take a vocational interest inventory, e.g., Strong's Vocational Interest Inventory or other.
- Complete TAM #14: Career Development.
- Use MO-View to assess personal interests and directions.
- Spend a day shadowing a person who is employed in a career or industry you are interested in.

Resources & References

- Select career related film or video from Modern Talking Pictures.
- Cabaup (1989). Activities for the Occupation Outlook Handbook.
- How to Succeed in the World of Work. Glencoe.
- MO-View, COPS, SIGI-Plus and related guidance material available in the school's guidance office.
- Missouri View Student Exploration Guide (IML 30-1020)
- Work attitudes and Human Relations in Business (IML 20-0004)
- Ryan, et al. (1986). Choices and Goals: An Individualized Career Exploration Computer Program.
- Career Planning Workbook (Vocational Studies Center).

Content	Teacher Plans & Activities
III. Employability Skills A. Job Seeking Skills 1. Applying for jobs 2. Interviewing for jobs 3. Resumes 4. References 5. Negotiation 6. Evaluating jobs	• Discuss key job seeking skills with students. Incorporate their application into the role playing associated with the class mass production activity. - How do you apply for a job over the phone? - How do you answer a newspaper advertisement of a job? - How do you interview for a job? - What type of clothing should be worn to an interview? - What information should be included in a resume? - Are there any techniques that will make interviews easier? - How is a job application form completed? - Who and what are personal references? - What should be done when offered more than one job? - What criteria should be used to evaluate job offers? • Set up and role play a job interview, preferably with a person from business/industry. Video tape and playback for evaluation. • Arrange for students to go on a simulated job interview. Arrange for participation of a range of professional and technical employers.
B. Personal & Relational Skills 1. Willing to follow directions 2. Punctual 3. Reliable 4. Able to get along with co-workers 5. Shows initiative 6. Demonstrates respect for others 7. Self-directed 8. Dependable 9. Able to communicate with others 10. Cooperative 11. Persevering 12. Willing to learn 13. Able to accept & profit from criticism 14. Personal hygiene	• Discuss key personal and interrelationship characteristics with students. Demonstrate how these apply as they work together in their mass production and other group projects. - The ability and willingness to follow directions - Punctuality - Reliability - The ability to get along with co-workers - Showing initiative - Demonstrating respect for others - Being self directive & completing tasks unassisted - Dependability - The ability to communicate with others - Being cooperative - Perseverance - Willingness to learn - Ability to accept and profit from criticism - Personal hygiene • Stress and illustrate importance of skills in getting and keeping a job. • Take advantage of opportunities to work through interpersonal problems or situations experienced in the lab or classroom.

Student Activities

- Participate in simulated job interview situations.
- Interview a person who has the kind of job that interests you. Ask about kinds of skills he/she had to have to get and keep the job, key interviewing skills, educational preparation, resume preparation, etc.
- In small groups, role play supervisor/worker problem resolution, contractual enforcement, etc.
- Review the Dictionary of Occupational Titles. Select and review several occupations of interest. Follow up with a visit to someone in the selected occupation to verify the information.
- Participate in a mass production project.
- Role play management/employee interactions, e.g., interviews, contract renegotiation, strikes, working conditions, discussions, etc.
- Write an essay, or develop a bulletin board/display, about what work will be like in the year 2050. Collect information by sending letters to appropriate persons, e.g., curator of the Smithsonian Institution, state governor, a fiction writer, AVA president, State Vocational Supervisor, an artist, Lee Iacocca and more. Don't limit yourself. Analyze the responses.
- Select a microfiche newspaper from 50 years ago and compare its references to work to those in one of today's newspapers. Compile a list of jobs and beginning salaries of several careers. Include retirement, quality of life, career changes, satisfaction, etc.

Resources & References

- Dagget (1989). The dynamics of work.
- Farr, et al (1987). The work book: Getting the job you want.
- Dictionary of Occupational Titles. (D.O.T.)
- Occupational Outlook Handbook.
- The Jeans Factory, video
- World Future Society resources on work and technology
- Como (1986). Surviving on the job.
- Visit colleges, technical schools, etc. that you may wish to attend.
- MVRC Employability & Entrepreneurship resources
- Junior Achievement resources

Content	Teacher Plans & Activities
IV. Occupations Identification Classifications A. Application Arena 1. Manufacturing 2. Construction 3. Service B. Level of Employment 1. Management 2. Supervision 3. Skilled 4. Semiskilled C. Technological Continuum 1. Scientist 2. Engineer 3. Technologist 4. Technician 5. Trades person 6. Semiskilled 7. Unskilled	• Outline the range of employment opportunities available in materials and processing related areas. Describe classifications by levels and by the technological continuum. • Set up situations where students experience career roles in the classroom or lab. • Discuss the growing importance of the service sector of the economy. • After the mass production project, conduct a debriefing focusing on the occupations, classifications & roles that students experienced. • Invite a local employer, employee and union representative and have each share their unique perspectives on work. • Highlight available career and trend information sources.
V. Career and Technological Trends A. Manufacturing/Construction B. Service C. Sales D. Management E. Labor F. Research & Development G. Resources H. Career Forecasting 1. Career Reconfigurations 2. New and Emerging Occupations	• Present examples of occupations which have become extinct due to changes in technology, e.g., key punch operators, babbitt workers, pin stripers, etc. • Present new and emerging technology-related occupations, e.g., software developers, fiber optics technicians, astronauts, space construction technicians, human/technology interface engineers, etc. • Brainstorm new materials and processing related job possibilities of the future, e.g., manufacturing and construction in space, "no boss" factories, etc. • Compare the technology of small communities with that of metropolitan areas.
VI. Education and Training A. On the Job Training 1. Apprenticeships 2. Journeymen B. Technical Training C. Professional Education 1. Scientist 2. Engineer 3. Technologist 4. Teacher D. Vocational Education 1. Technician 2. Skilled trades 3. Semiskilled trades	• Present various educational & training possibilities for materials and processing related careers. • Have a recent alumni of your program visit the class to discuss that person's current educational experience. (Focus on the decision-making process, possibilities, preparation, etc.) • Show what vocational/technical and professional programs, related to technology and the students' interests, are available. Similarly point out where to get financial aid information. • Describe quality characteristics of educational programs.
VII. Entrepreneurial Activity & Opportunity A. Opportunity B. Advantages/Disadvantages C. Requirements	• Invite an individual who has been successful as an entrepreneur to speak with the class. Encourage discussion of how to get started, possibilities and opportunities, problems, strategies, etc.

Student Activities

- Prepare a chart that shows the organization structure, positions, names of person holding them and technological level of an enterprise near the school.
- Prepare a play that demonstrates the career and technological trends for a local enterprise over the next 50 years.
- Report on the training required to enter in the students most popular job choice.
- Telephone or interview people working in technological jobs and chart the inservice education they participate in.
- Describe the various types of business ownership.
- Participate in career day opportunities provided by colleges and/or technical schools.
- Describe the characteristics of a free enterprise system, e.g., ownership of property, profit motive, risk taking, competition, supply & demand.
- Research the steps employed by local entrepreneurs in starting their businesses. Compare the sequences used by different entrepreneurs.
- Discuss and work out a class consensus about what are the key entrepreneurial characteristics.

Resources & References

- ________. (1987). Career Information Center (Glencoe)
- Williams, et al. (1989). Technology for tomorrow.
- Kimbrell & Vineyard (1986). Succeeding in the World of Work.
- Missouri Comprehensive Guidance Kit (IML 30-2075)
- American Enterprise (video series, Phillips Petroleum)

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Introduction to Materials & Processing Technology

Unit 7: Careers in Materials & Processing Technology

Instructor Notes:

Start: _____ End: _____ Items to Order

Suggested Revisions:

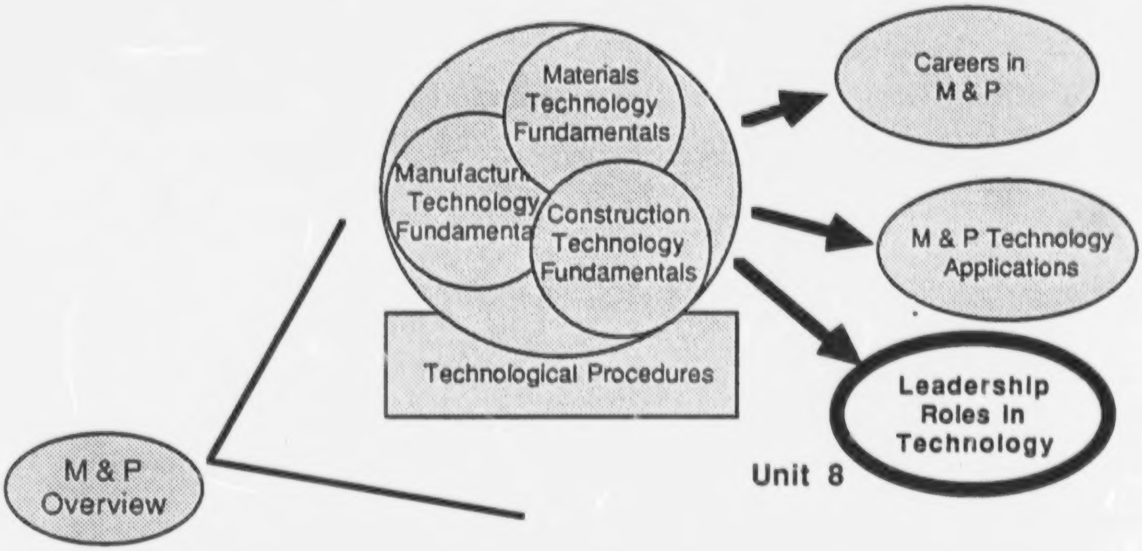
Advisory Group Input:

Missouri

Introduction to Materials & Processing Technology

Instructor Guide

Unit 8: Leadership Roles in Technology



Materials Technology Fundamentals
Manufacturing Technology Fundamentals
Construction Technology Fundamentals
Technological Procedures
Careers in M & P
M & P Technology Applications
Leadership Roles in Technology
Unit 8
M & P Overview

The purpose of this unit is to develop the characteristics, qualities and roles of leadership, particularly as they pertain to technological settings. The focus will be on personal, occupational and organizational skills.

Unit Eight: Leadership Roles in Technology

OBJECTIVES: The purpose of this unit is to develop student characteristics and abilities related to leadership. Lessons will focus on personal, occupational and organizational assessment and opportunities.

COMPETENCIES -- The student will be able to:

1. Identify characteristics necessary for leadership in technology. (8,I)
2. Identify key historical and contemporary leaders in technology. (8,I)
4. Identify the leadership quality characteristics of both present and past leaders in technology. (8,I)
5. Describe and illustrate qualities contributing to effective leadership. (8,II)
6. Demonstrate leadership in individual activity related to the course. (8,II)
7. Employ leadership skills in performing officer duties and guiding student organization activity. (8,III)
8. Work cooperatively with others in leader and follower roles. (8,III)
9. Bring group activity to a successful conclusion. (8,IV)
10. Describe the purposes of student organization activity. (8,IV,A)
11. Participate effectively in local, state and/or national clubs. (8,IV)

*[notations in parenthesis identify the Unit number and Content outline section(s) that the competency refers to]

Content

I. Characteristics of Positive Leadership
   A. Characteristics of Leadership
   B. Motivation and Leadership
   C. Examples of Leadership

II. Individual Leadership
   A. Know personal strengths & limitations
   B. Validate how others see you
   C. Consistency
   D. Dependability
   E. Initiative
   F. Sense of purpose

III. Group Leadership
   A. Inspire confidence
   B. Resolve conflict
   C. Communicate effectively
   D. Evolve vision of goal(s)
   E. Organize resources effectively
   F. Manage operation

IV. Student Organization Activities
   A. Purposes
   B. Key National Organizations
      1. Technology Student Association
      2. Vocational Industrial Clubs of America
      3. Epsilon Pi Tau
      4. Junior Achievement
      5. Trade/Professional associations
   C. State & Local Organizations
      1. Missouri Industrial Technology Students Association

Teacher Plans & Activities

- Conduct a session identifying examples of key historical or contemporary leadership figures. Leadership may be positive or negative and may be technologically or non-technologically oriented, e.g., Louise Blanchard Bethune, Amelia Earhart, Thomas Edison, Henry Ford, Thomas Jefferson, Richard Nixon, Eleanor Roosevelt, Margaret Thatcher, etc. Brainstorm the qualities (personal and professional) that students identify as leadership qualities. Show the impacts of each and chart them.

- Review and role play Roberts Rules of Order with students.

- Initiate and provide active sponsorship to a student technology educational organization.

- Involve students in competition events at local, regional, state and national levels.

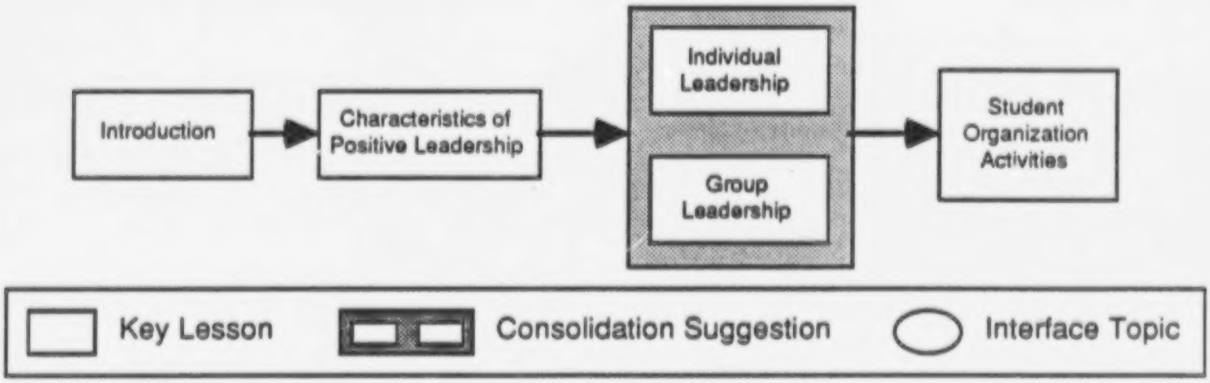
- Encourage student membership in national student organizations.

- Secure TSA materials, involve students in planning and implementation of a technology fair/competition.

- Form an honor society

- Encourage student to run for local, state and national association offices.

Lesson/Activity Outline



Student Activities

- Conduct a meeting using Roberts Rules of Order.
- TAM #15: Leadership Development.
- Assume responsibility for making arrangements for a class visit to a manufacturing or construction site, e.g., local entrepreneurs, cabinet shops, auto repair shop, lawn mower repair shop, etc.
- Organize a cookout or appreciation banquet recognizing construction and manufacturing leaders who have hosted field trips, served as guest speakers, provided resources, etc. Role play meeting, greeting, thanking, etc.
- Organize and implement a club sponsored service workday for an organization or group in your community.
- Run for national or state office in a student technology organization.
- Enter a Missouri Industrial Technology Education Association awards program student association competition. Participate in local and regional events
- Observe other student association activity/ events, e.g., FHA, FFA, VICA, DECA, FBLA, etc.
- Participate in establishing an industrial technology students' organization.
- Serve as an officer in a student organization.
- Conduct, for your school or community, a service project through your student organization.
- Role play group work, leadership roles and their interrelation.

Resources & References

- Hart (1987). Missouri Student Association Activity Guide.
- Work attitudes & human relation in business (IML 20-004)
- You can do it, recruitment video (Paxton-Patterson)
- Diversified Technology. (n.d.). Effective Leadership Module
- TSA (1988). TSA Competitive Events Guidelines.
- TSA (n.d.). Technology Students Association Member Guide.
- National Vocational-Technical Honor Society, P.O. Box 1265, Grambling, SC 29348
- Pfeiffer (1988). University Associates training and development kit.

Missouri

Introduction to Materials & Processing Technology

Unit 8: Leadership in Technology

Instructor Notes:

Start: _____ End: _____ Items to Order

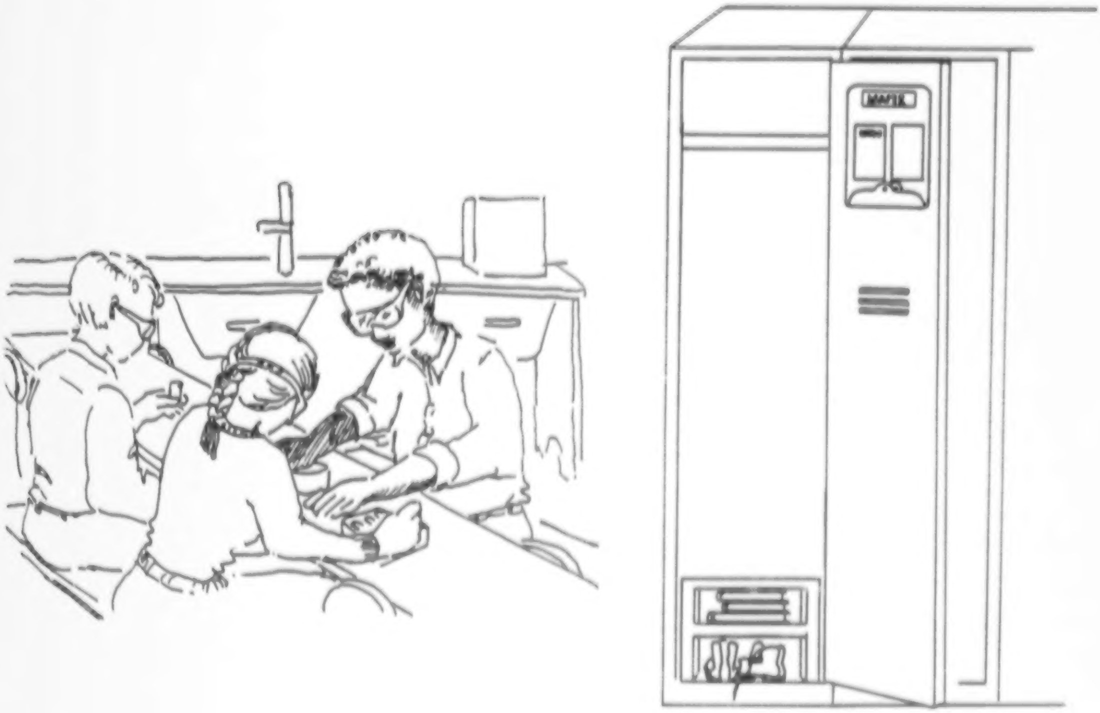
Suggested Revisions:

Advisory Group Input:

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #1

First Week Production Activity



TAM #1: First Week Production Activity

Instructor Component

Activity Objective: The purpose of this activity is to generate interest in the course by involving the students in a wide range of activities via a First Week Production Activity. The processes they will encounter include: planning, design, manufacturing simulation (production) and a field trip.

Activity Competencies: By completing this TAM, the student will be able to:

1. Define and explain the technical terms and concepts used to describe the principles, mechanisms and systems associated with materials and processing technology. [1,I]
2. Describe and illustrate major materials processing processes, their components and their key variables. [1,I,A,B,C]
3. Provide examples of the major types of materials processing systems [individual, artistic, mass, continuous, job]. [1,IV]
4. Explain selected chemical concepts involved in the processing of metals, plastics, ceramics and cellulose materials. [1,V,A]
5. Demonstrate the safe and proper use of materials and processing technology tools, equipment, materials and processes to manufacture and construct products. [1,VII]
6. Select and apply the appropriate fasteners. [5,II]
7. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,VI]
8. Describe various finishing materials, citing the advantages, disadvantages, characteristics and purposes of each and demonstrate their correct applications procedure. [5,II,5V]
9. Prepare a complete bill of materials from a working drawing. [5,II]

Module Instructions

Introduction:

This activity is designed to immediately immerse students in motivating activities during the first week in class. The TAM consists of design and processing methods applied to a production activity. It also includes a field trip to a manufacturing plant(s). This activity should be integrated with appropriate classroom presentation of materials and processing technology. The activities in this module include safety instructions, pre-test, post-test, a field trip, demonstrations of processes and a production activity. Remember this is only an introductory activity. Students will develop more depth during the remainder of the course.

Safety Considerations:

Safety precautions should be observed in dealing with all materials and equipment in this activity module. This is particularly important since it is the first time that you as an instructor will see these students in the laboratory setting. Therefore plan carefully to:

1. Develop a permanent safety consciousness in students through example setting.
2. Avoid scare tactics and attempt to instill accident prevention from a positive approach.
3. Develop in each student a sense of responsibility for his/her own actions and safety as well as that of others.
4. Train students to recognize hazards.
5. Develop a common signal to bring everyone to attention in the event of an accident.
6. Review each specific safety instruction sheet.
7. Review instructions for evacuating the laboratory and for emergency notifications procedures.

Needed Materials:

1. **Supplies**

Name Plate

- Wet or dry abrasive paper
- Aluminum
- Carbon paper
- Pop rivets or adhesives
- Masking tape
- Asphaltum varnish
- Brush
- Sharp knife
- Hydrochloric acid

Locker Organizer

- Steel tape measure
- Aluminum or copper
- Hot water
- Carbon paper
- Hydrochloric acid (diluted)
- Thinner or lacquer
- Pop rivets
- Asphaltum varnish
- Watercolor brush
- Nitric acid (diluted)
- Spray can

Screen Printing

- Light/heat sensitive screen material
- Custom-made artwork/design
- Frame for stretching the screen material
- Ink suitable for the product
- T-shirt to print on
- Pressing iron

2. Equipment

Name Plate

- Jigs
- Drill press
- Hand tools

Locker Organizer

- Shears
- Drill press

Screen Printing

- Computer
- Transparency copy machine
- Printing press, if available

3. Handouts

A. Student Component of TAM #1
B. Safety Handout (Refer to appropriate pages in student component of TAM 1)
C. Working in the Laboratory Handout. (Refer to appropriate pages in student component of TAM 1)

4. Instructional Resources

A. Film (Select overview film/video from media source suggestions in Section III's part 4 of this M & P Guide, e.g., "For Years To Come" or "Just in time" from Chrysler Corporation.)
B. Books and Articles

Dyrenfurth, M. J. & Linhardt, R. A. (1981). Vocational safety guide. Columbia, MO: Instructional Materials Laboratory, University of Missouri, Columbia. pp. 15-31.

Ebert, S. et al. (n.d.). Safety education handbook. Johnson, KS: Kansas State Department of Education. vol.1. pp. 144-147.

Ebert, S. et al. Safety education handbook. Johnson, KS: Kansas State Department of Education. vol. 3. pp. 1729-1736.

Maley, D. A. (1978). The industrial arts teacher handbook techniques: Principles and methods. Boston, MA: Allyn & Bacon. pp. 11-92.

Silvius, H. G. & Curry, E. H. (1967). Teaching successfully in industrial education. Bloomington, IL: McKnight & McKnight. pp. 11-92.

C. A guest lecturer

To be invited from wherever available and appropriate, e.g., local Society for Manufacturing Engineering chapter.

Management/Logistics:

1. **Related TAMS**

TAM #2, Problem Solving.

2. **Evaluation/Grading**

A. Evaluate the students' designs/sketches based on effective criteria of function and aesthetics. Base the evaluations on a prototype.

B. Use post-test/pre-test gain to evaluate students.

3. **Suggested Schedule/Time**

The activities in this TAM should be performed in one week.

4. **Instructional Management**

Overall: In order to accomplish this TAM in the limited time available, instructors must be very well prepared with jig, supplies and all details ready.

Field trips:

This is an effective way to study key functions of industry. It is a valuable experience, particularly in shaping student attitudes and impressions.

Field trips are to be taken as part of regular classwork and only after the students see the need for them. The students can also suggest a field trip to find the answers to questions raised in discussions, problem solving, from reading and/or experience. Often, it is useful to include the class in planning the trip.

Planning the trip:

Most schools have detailed rules that must be followed. Generally, schools require that parents or guardians complete an approval form before the trip takes place. A sample is attached after this section.

The teacher should familiarize him/herself with the place to be visited in order to better inform students what to observe.

Copies of the signed approval slip should be kept on file. In addition, prepare duplicate lists of all students participating. Every student participating should know the rules and regulations of the trip.

Planning what to learn:

Whatever will take place during the trip should be planned and discussed in advance by the class. Include what is to be seen and done. After completing the plan, each participant group should select questions or be allocated an assignment, to document their observations.

Conducting the trip:

Students must be instructed to stay close to the instructor or guide after arriving at their destination. Pocket-sized notebooks or notecards are convenient for taking notes. Remind students that they represent their school and community, and therefore they should conduct themselves as adults, particularly since this is the company's first impression of them.

Concluding Activities and Follow-up:

The information and knowledge acquired should be discussed immediately after the trip. All the questions raised earlier should be answered. Both the instructor and students should summarize the important points, or students may be assigned to prepare a summary before the next class.

It is hoped that field trips will lead to more student activities, e.g., research and experimentation, etc. The instructor should utilize the learning potential inherent during the trip period. Have a contact at the plant prepared to field students' questions.

A letter of thanks should be sent to all officials responsible for the visited facility. Students should be requested to write such letters and mail them to the people in charge of the visited facility.

Field Trip Permission Slip

Name of School: ______________________________

Department Name: ______________________________

The Industrial Technology Education class your son/daughter is enrolled in will

participate in a field trip to __________________ place on________________.
(Destination) (Date)

We plan to take a bus, leave the school at __________ and return at __________ .
(Time) (Time)

The purpose of this trip is to give students a first-hand experience in technology and to broaden their technological thinking. Please note your agreement to having your son/daughter participate, by signing below. Then have your son/daughter return this permission slip to the instructor as soon as possible.

Parent/Guardian Signature: ________________________ Date: ________

Key Instructional Suggestions:

1. **Safety**

   The instructor should double check to be sure that all potential safety problems are addressed. These will vary with the design chosen by the students for their mass production activity.

   - Review fire safety rules - sample follows this section.
   - Review Working in the laboratory (Safety handout) with students.
   - Doublecheck all etching solution concentrations, procedures and first aid treatment in advance with knowledgeable experts.

2. **Motivation**

   Put all the prototypes produced on display in the classroom for a week.

3. **Prerequisite Information**

   None

4. **Demonstrations**

   The instructor should provide interesting activities that will relate to this activity module by giving demonstrations to the students about:

   - Etching
   - Line Production - using jigs and fixtures
   - Screen Printing

5. **Reinforcement**

   A. Present the class with a film/video related to the key processes in the students' chosen production activity.

   B. Schedule a field trip to a manufacturing plant.

6. **Attitudes**

   The instructor should reward the best three prototypes produced with money or a token gift from the previous production run.

7. **Remediation/Enrichment**

   A. Remediation: Assign a second but simpler,design problem that is related to this TAM.

   B. Enrichment: Introduce advanced students to the design for assembly approach. Have them research it and then apply the process to a new design problem.

8. Summary & Review

A. A summary and review of the following points will be helpful:

1. Etching: Line, area
2. Field trip: Key observations
3. General safety rules and regulations
4. Line production processes
5. Screen printing processes

9. Review Questions & Answers *(Answers are in italics)*

A. Define and explain the following:

1. Area etching -- *Is done by applying a resist to areas that are not to be etched. These areas are in high-relief.*

2. Line etching -- *Lines cut through the resist with a sharp instrument.*

B. Compare and contrast area and line etching:

Area etching and line etching. *Area etching is used more often than line etching. In area etching, the etched background is in low-relief, while in line etching the complete metal surface is covered with a protective resistant.*

C. Explain how field trips relate to the course. *Taking a field trip is an effective way to study key functions of industry. It is a valuable experience for students in shaping students' attitudes towards the course. It can be included as part of regular classwork.*

D. Describe and illustrate major line production processes and the planning needed before beginning them.

1. *Plans*
   - a. *design*
   - b. *design transfer*
   - c. *masking*
   - d. *painting*
   - e. *etching*
   - f. *removal of acid*

2. *Cut blanks*

3. *Drill holes*

4. *Treat edges*
   - a. *wet/dry abrasive paper*
   - b. *spray*
   - c. *dry*
   - d. *mount*

5. *Storage*

Fire Safety: General Safety Rules

1. Do not smoke in the laboratory.
2. In the event of a fire and/or alarm, follow the prearranged plan (as posted) immediately after shutting down your machine.
3. Store flammable or combustible liquids in special containers and cabinets in accordance with industrial specification, e.g., OSHA.
4. Review procedures for use of fire extinguishers and blankets.
5. Insure regular inspection of fire extinguishers.
6. Review typical fire procedures such as:
    - a. sounding the alarm
    - b. turning off master electricity and gas controls
    - c. determining the type of fire and taking appropriate action
    - d. leaving the building when personal safety is endangered
    - e. notifying security/fire control immediately
7. Place all oily waste rags in self-sealing containers.

Date: _______ Class: _________________ Name: ______

TAM #1 - Pre-test (First Week Activity)

Instructions: Fill in the blank spaces below with the correct word(s):

1. Etching is a process of _______ away a surface by chemical ________ where the surface is not protected by a resistant coat. [M & P, T#1,1]
2. Two types of etching styles are:_________ and ______________. [M & P, T#1,1]
3. Some of the materials used for etching are: (Name any four) [M & P, T#1, IV,]
   a. _______________
   b. _______________
   c. _______________
   d. _______________
4. Name two methods that can be used to apply resist: a.______________ and b.______________. [M & P, T #1,1]
5. A field trip is an ______________ to study selected functions of ______________. [M & P, T #1,1]
6. Production is simply __________________ the form of materials to__________________ them more useable. [M & P, T #1,1]
7. Production, when done in a factory, is called _________. Production done on a site where the product will be used is called ________________. [M & P, T #1,1]
8. Name any four of the materials used in the sample line production. [M & P,T#1,1]
   a. _______________
   b. _______________
   c. _______________
   d. _______________
9. The two methods used in screen printing are:
   a. _______________
   b. _______________

TAM #1 - Post-test -- Rating Form (First Week Activity)

Course: Introduction to Materials & Processing Technology **Date:** ________

Tam# 7 **Title:** First Week Activity

Student Name: ______________________________________

Performance Rating
Poor **Excellent**
TASK 1 2 3 4 5

Etching:

1. Was the metal successfully cleaned with powder and water? __:__:__:__:__
2. Did the resist adhere to metal? __:__:__:__:__
3. Was the design successfully transferred to the project? __:__:__:__:__
4. Was the design successfully etched into the project? __:__:__:__:__
5. Was the project cleaned of acid, neutralized and washed with water? __:__:__:__:__
6. Was safety observed? __:__:__:__:__
7. Was clean-up done properly? __:__:__:__:__

Sample Line Production:

1. Were the blanks cut to size successfully? __:__:__:__:__
2. Were the mounting holes drilled properly? __:__:__:__:__
3. Were all edges sanded and contoured properly? __:__:__:__:__
4. Was the locker organizer finished well? __:__:__:__:__
5. Was the name plate mounted to the locker, using foam tape successfully? __:__:__:__:__

Screen Printing:

1. Did you produce the design you wanted on the silk screen successfully? __:__:__:__:__
2. Did you figure out how to get the design on your T-shirt successfully, using either heat transfer or silk screen method? __:__:__:__:__
3. Was the application of the image to the T-shirt done properly? __:__:__:__:__
4. Did you prepare the T-shirt for printing successfully? __:__:__:__:__
5. Was the ink applied to the screen away from the screen opening? __:__:__:__:__
6. Was the proper squeegee selected? __:__:__:__:__
7. Did you lower the frame onto the T-shirt successfully? __:__:__:__:__
8. Did you squeegee ink across the artwork properly? __:__:__:__:__

Field Trip:

1. Did you participate in planning the trip? __:__:__:__:__
2. Did you record your observations during tour? __:__:__:__:__
3. Did you participate in trip discussions? __:__:__:__:__

Total:____

TAM #1 - Test Keys (First Week Activity)

TAM #1 - Pre-test Answers

1. Etching is a process of eating away a surface by chemical action where the surface is not protected by a resistant coat. [M & P, T#1,1]

2. Two types of etching styles are: line etching and area etching . [M & P, T#1,1]

3. Some of the materials used for etching are: [M & P, T#1, IV,]

   Name any four of these, in any order:

   a) Acid resist enamel
   b) Asphaltum varnish
   c) Lacquer
   d) Beeswax brush
   e) Masking tape
   f) Knife
   g) Copper
   h) Brass
   i) Pewter
   j) Aluminum
   k) Water

4. Name two methods that can be used to apply resist: a. masking tape method and b. asphaltum varnish . [M & P, T #1,1]

5. A field trip is an effective method to study selected functions of industry . [M & P, T #1,1]

6. Production is simply changing the form of materials to make them more useable. [M & P, T #1,1]

7. Production, when done in a factory, is called manufacturing . Production done on a site where the product is to be used is called construction. [M & P, T #1,1]

8. Name any four of the materials used in the sample line production. [M & P, T#1,1]

   a) Aluminum
   b) Foam tape
   c) Paint
   d) Jig machine
   e) Wet or dry abrasive paper
   f) Hydrochloric acid (diluted)

9. a) Heat transfer method
   b) Silk screen method

TAM #1 – Post-test Answers

A rating scale form is used as a post-test.

TAM #1: First Week Production Activity

Student Component

Introduction:

This First Week Production Activity is an exciting activity to begin your study of Industrial Technology. It is an excellent way to learn what makes industry "tick" and it involves your first project this year. The activities are relatively simple, interesting and quick to perform. The activities may include: designing a name plate for your locker by etching aluminum, copper or brass; producing a locker organizer; screen printing and a field trip.

Competencies: Following completion of this activity module, you will be able to:

1. Define and explain the technical terms and concepts used to describe the principles, mechanisms and systems associated with materials and processing technology. [1,I]
2. Describe and illustrate major materials processing processes, their components and their key variables. [1,I,A,B,C]
3. Provide examples of the major types of materials processing systems [individual, artistic, mass, continuous, job]. [1,IV]
4. Explain selected chemical concepts involved in the processing of metals, plastics, ceramics and cellulose materials. [1,V,A]
5. Demonstrate the safe and proper use of materials and processing technology tools, equipment, materials and processes to manufacture and construct products. [1,VIII]
6. Select and apply the appropriate use of fasteners. [5,II]
7. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,V]
8. Describe various finishing materials, citing the advantages, disadvantages, characteristics and purposes of each and demonstrate their correct applications procedure. [5,II,5V]
9. Prepare a complete bill of materials from a working drawing. [5,II]

Module Overview:

This module contains two related activities, the first of which has three alternatives:

A. A production activity

1. Etching a name plate for your locker, or
2. Building a locker organizer and/or
3. T-shirt screen printing.

All can involve mass production

B. A field trip

Key Information:

1. Class Presentations

Production: The problem-solving steps you will use include:
- Researching the product
- Defining the problem
- Slide presentation of past products
- Class discussion
- Brainstorming
- Selecting alternatives
- Narrowing the field
- Picking the best alternative
- Implementing the chosen solution to the problem
- Evaluating the solution

Field Trips:
- Planning the trip
- Observations during the trip
- Concluding activities and follow-up

2. Demonstrations

Etching (Name Plate)
- Line etching
- Area etching

Using Jigs and Fixtures (Locker Organizer)
Screen printing (T-shirt)

3. Safety

Major concerns related to this TAM's activity :
- Chemical
- Gloves
- Apron
- Ventilation
- Waste disposal
- Tools usage
- Safety glasses (splash resistant)
- Field trip behavior

4. Personal Activity

As your homework, you are required to read professional magazines and trade journals that contain information related to this TAM and the following book (if doing the name plate) before starting on this activity:

Johnson, H. V. (1981). Technical metals. Peoria, IL: Chas. A. Bennett Co. pp. 160-161.

5. Other

Glossary:

Design	The artwork the student will etch into the project.
Production	The process of changing the form of materials to produce the intended design, which adds to the worth of a product.
Etching	The process of applying acid (a reactive solution) to remove unprotected surfaces of a metal.
Aluminum	A bluish silver-white, malleable, ductile, metallic element with good electrical conductivity
Asphaltum Varnish	A viscous petroleum-based substance used to coat a product's surface. This coat resists the acid's reaction, leaving the unprotected surface etched.
Acid	A chemical that can be found in any form, (liquid, gas or solid) which will eat metal and other substances. It is capable of reacting with a base to form a salt .
Jig	A type of fixture with means of positively guiding and supporting tools for drilling or boring of related operations.
Rivets	Pins with heads used for joining two or more pieces of metal.
Abrasive Paper	A paper covered on one side with an abrasive material, glued fast. It is used for smoothing and polishing.
Painting	A process of applying a protective coating to produce a final, durable finish. The coating may be clear or colored.

Needed Materials:

1. Supplies

Name Plate

- Wet or dry abrasive paper
- Aluminum
- Carbon paper
- Pop rivets or adhesives
- Masking tape
- Asphaltum varnish
- Brush
- Sharp knife
- Hydrochloric acid

Screen Printing

- Light/heat sensitive screen material
- Custom-made artwork/design
- Frame for stretching the screen material
- Ink suitable for the product
- T-shirt to print on
- Pressing iron

Locker Organizer

- Steel tape measure
- Aluminum or copper
- Hot water
- Carbon paper
- Hydrochloric acid (diluted)
- Thinner or lacquer
- Pop rivets
- Asphaltum varnish
- Brush
- Nitric acid (diluted)
- Spray can

2. Equipment

Name Plate

- Jigs
- Drill press
- Hand tools

Screen Printing

- Computer
- Transparency copy machine
- Printing press, if available

Locker Organizer

- Shears
- Drill press

3. Handouts/Instructional Resources

A. Safety Handout (in student component of TAM 1)
B. Working in the Laboratory Handout. (in student component of TAM 1)

Working in the Laboratory

1. Remember, if in doubt, ask your instructor. If helped by another student, confirm his/her suggestion with the instructor.
2. Be courteous and helpful to each other. Caution any classmates that violate safety guidelines.
3. Always give the job/operation you are doing your undivided attention.
4. Never assume that something is safe, that someone is clear or that others know where you are and what you are doing.
5. Be particularly cautious and concerned for the safety of visitors. They may not know proper procedure!
6. Avoid horseplay/clowning/practical jokes. The safety of fellow students must not be jeopardized by carelessness or indifference.
7. Know the locations of:
   a. fire exits
   b. power shutoff switches/main breaker panel
   c. fire extinguisher/blankets
   d. first-aid kit
   e. eyewash station
8. Report any accidents, unsafe acts and unsafe situations to the instructor immediately, no matter how minor they seem.
9. When possible (and when you are certain of the proper course of action) correct an unsafe act/situation. Note: be careful that in doing so you do not create another hazard.
10. Obey signs.
11. Prior to set-up and operation, students must read/review and understand the specific safety rules prepared for the equipment to be used.
12. Look where you are going an do not run in the laboratory.
13. Students may only use hand tools, machines and other laboratory equipment and special materials after receiving proper instruction from the teacher responsible for the course. Usually this instruction consists of:
    a. observing a demonstration/lecture
    b. passing a performance/safety test
    c. being properly attired
    d. obtaining instructor consent
14. Tag all hazardous and defective equipment appropriately
15. Do not place small parts in the mouth or taste/inhale laboratory materials
16. Repair equipment only with instructor's permission
17. When lifting heavy objects, use proper techniques (let the legs lift -- not the back) and/or get assistance. Be especially careful when setting down heavy loads.

Safety Handout TAM #1

The purpose of this handout is to help you to work safely with tools and other equipment that you will use when performing an activity in this TAM.

The proper safe attitude is very important in preventing accidents. Safe practices and proper methods are for you.

While you are working in this TAM, you are required to follow these guidelines:

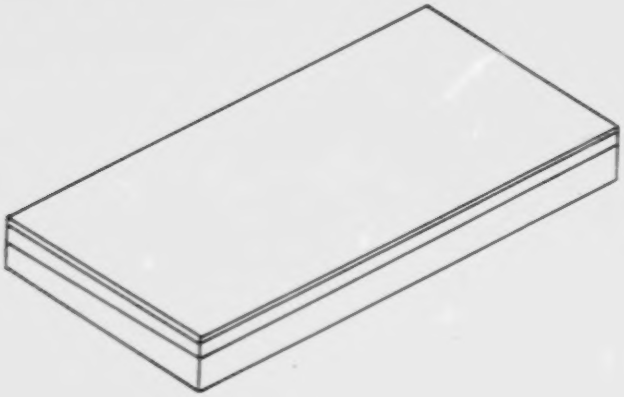
1. Roll your sleeves above your elbows.
2. Remove your tie or scarf or tuck it in your shirt.
3. Wear a shop coat or apron to protect your clothing.
4. Use rubber gloves to protect your hands from acid.
5. Do not pour water into acid; an explosion may take place.
6. Wear goggles in all work areas where eye hazards exist.
7. Make sure there is enough/adequate ventilation in laboratory/room. and air in the shop/laboratory is free from excessive dust, fumes, etc.
8. Clean the area you worked in after completing your activity.
9. Clean any chemical spills immediately.

TAM #1: First Week Activity

Activity #1A - Producing an Etched Nameplate: Plan of Procedure

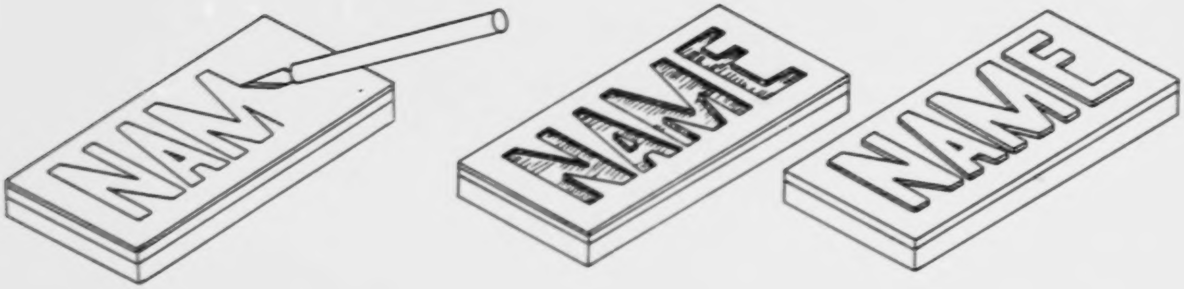
The time required to etch varies according to the concentration of the acid and the depth of etching wanted. It takes 1 to 2 hours for copper; 1 to 1-1/2 hours for brass; 15 minutes for pewter and 30 minutes for aluminum.

1. Cut the nameplate blanks to size.



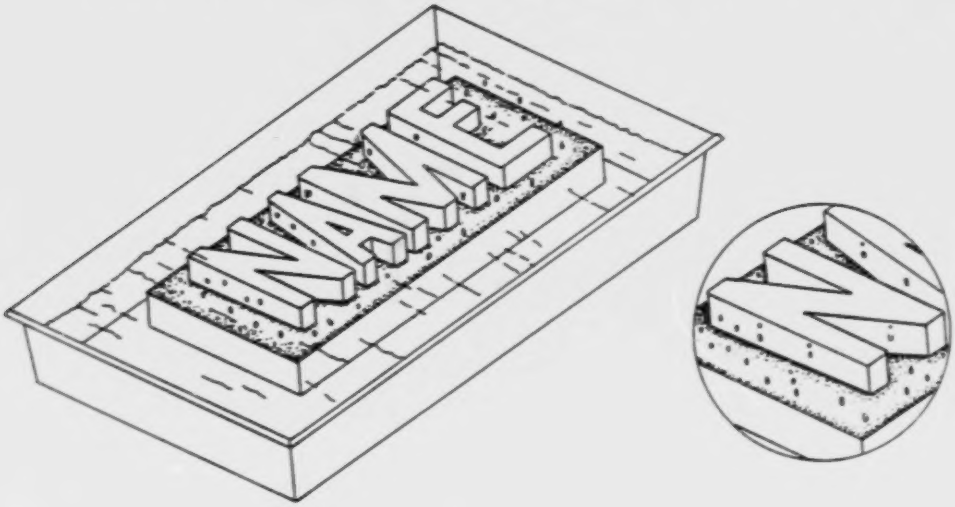
2. Clean the metal by scrubbing with fine pumice powder and water; rub in one direction only.

3. Apply the resist using one of the following methods:
   A. Masking Tape Method:
      1. Cover the material with tape. Then transfer and draw the design onto the paper surface.
      2. With your sharp knife, cut around the area to be etched.
      3. Carefully remove tape from this section.

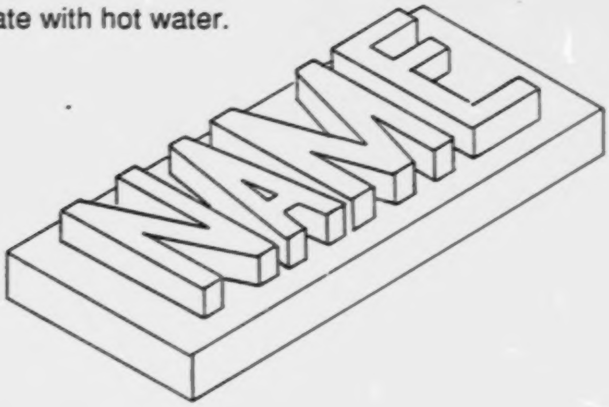


B. Asphaltum-Varnish Method: Gently transfer or draw the design on the metal by tracing with carbon paper.
   1. Paint the design with asphaltum, using a small water-color brush.
   2. Cover all parts of the work not to be touched by acid.
   3. Dry overnight.

4. Place the nameplate in a glass tray and put on splash-resistant goggles, gloves and an apron.
   A. Pour in enough acid to cover the work.
   B. Rock the tray gently and brush off bubbles that form on the work.
   C. Allow to etch until the desired depth is obtained.



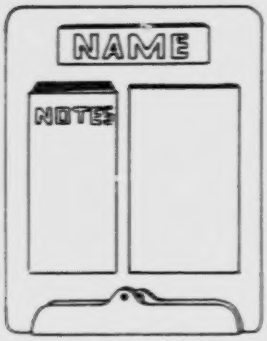
5. Wash off all traces of acid from the nameplate.
6. Soften the resist by holding the nameplate over a warm furnace. A soldering furnace can be used.
7. Be sure to shut off all flames and cool the nameplate. If it is hot it can ignite the solvent. Then use a cloth soaked in turpentine or lacquer thinner to remove the resist.
8. Wash the nameplate with hot water.

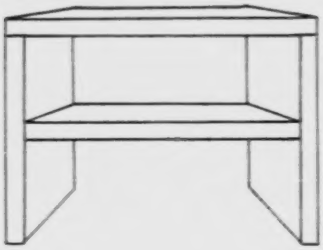


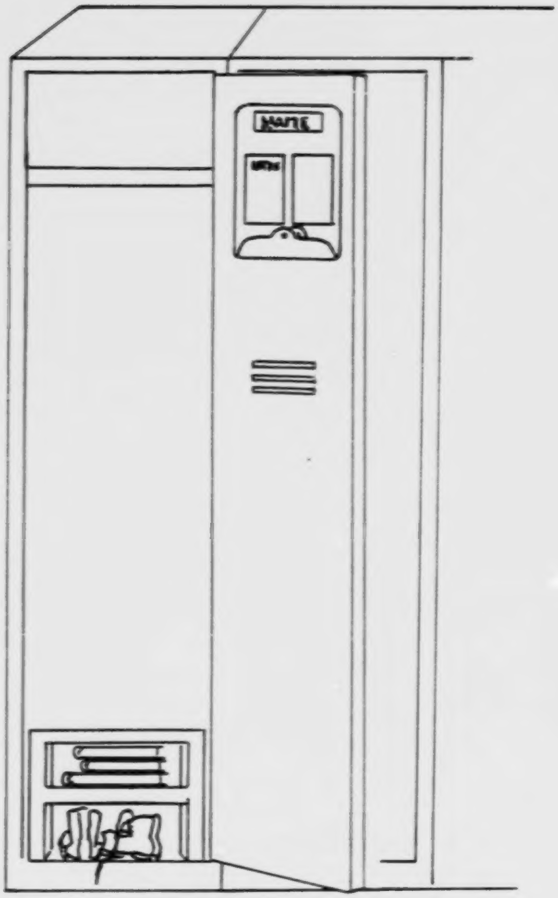
9. Polish the nameplate's raised surface with steel wool or a fine abrasive.
10. Drill two holes with jig.
11. Treat edges by sanding them smooth with wet or dry abrasive paper.
12. Allow nameplate to dry by applying heating or light.
13. Mount nameplate to locker using pop rivets or foam tape.

Activity #1B - Producing Locker Organizer: Plan of Procedure

1. Define the problem -- design of a locker organizer.







2. Set parameters for:
    - a. nameplate (etch)
    - b. mirror
    - c. pencil holder
    - d. clipboard
    - e. shelves
    - f. bowl
3. Measure available space with steel tape measure.
4. Sketch tentative design for the project.
5. Brainstorm to get best ideas.
6. If possible, review and refine your idea(s).
7. Make a prototype.
8. Estimate the bill of materials.

9. Make a flow chart of your production

10. Build jigs and fixtures.
11. Secure materials.
12. Complete production.

Activity #1C - T-Shirt Screen Printing: Plan of Procedure

1. Produce the design you want on the silk screen.
   a. Draw it
   b. Copy it from a magazine
   c. Use computer to draw it

2. Figure out how to get the design on the T-shirt, using any of the following stencil creating methods:
   a. Heat transfer method
   b. Silk screen method
      1. You produce stencil manually
      2. You produce stencil using computer and printer with special silk screen
      3. You produce stencil photographically

3. Apply the stencil/image to the silk screen frame.

4. Prepare the T-shirt for printing; place on printer and stretch lightly.

5. Apply ink to the screen opening.

6. Select the proper squeegee.

7. Lower the frame onto the T-shirt.

8. Hold the frame down firmly in contact with the T-shirt.

9. Squeegee ink across the stencil.

10. Raise the screen. Remove the T-shirt and place on drying rack.

11. Repeat steps 1-10 for additional T-shirts.

Activity #2 - Taking a Field Trip: Plan of Procedure

This is an efficient and effective way for you to study key functions of industry. A field trip is used to expose you to vocational options in industry and to technology that is not possible in the school's laboratory. The best way to develop your knowledge and experience is to take you to the industry. However, to maximize the value of the trip, you need to:

1. Have a clear idea in mind of where you are going; be alert in what you are doing.
2. Follow school rules.
3. Have an approval form completed by your parents/guardians before you go on the trip.
4. Participate in the class discussion to plan the trip. You need to specify things to observe at the plant and questions to be answered by the visit.
5. Stay close to the instructor and/or guide after arriving at your destination.
6. Use your note cards or pocket-sized notebooks for taking notes.
7. Participate in the class discussion that will take place after the trip. Be ready to raise any remaining questions and to discuss your observations.
8. Summarize and review the important points.
    a. Planning the trip
    b. Observations during the trip
    c. Concluding activities and follow-up

Field Trip Report Form

Student Name: ________________ Class: ____________ Date: ____________

During your field trip, make careful observations and record answers to the following questions. (The class will be divided into three groups and each group will discuss its assigned questions.)

1. Did the company have a good communication system?, e.g., the transmission system, reception/decoding and feedback.

2. Are the components and technology of the communication process effective?

3. What methods were used in accessing and storing information?

4. What materials and processing technology processes were employed at the site?

5. How effective were the technological procedures?

6. How would you characterize the company's materials handling technology?

7. What kind of construction technology fundamentals were observed?

8. What quality control processes were used with their manufacturing?

9. Are their materials and processing technology applications efficient?

10. What are some of the careers in materials and processing technology that were observed?

11. How were the leadership roles of the company's officers evidenced?

TAM #1 - Summary

1. **Review & Summary Activities**

   The activities in this module provide you with an enormous challenge. Also, they will help in widening your knowledge and experience in industrial technology, thereby building a base that is of fundamental importance to you.

   The manner and atmosphere in which you work in this activity module is extremely important. Your attitude towards the work you produce and the amount of effort you put forth will determine how seriously you accept the challenge of this activity module.

2. **Review Questions -- Test yourself!**

   A. How do people dress in a manufacturing plant?
   B. How do people act in a manufacturing plant?
   C. How do people interact in a manufacturing plant?
   D. What does the plant layout look like?
   E. What evidence of safety for the workers did the plant exhibit?
   F. Explain the concept of etching.
   G. Describe improvements for the nameplate production process.
   H. What are the most important characteristics of fasteners and adhesives used in line production?
   I. Describe the two methods used in figuring out how to get the design on a T-shirt.
   J. How would you produce the design you want with the heat transfer method?

TAM #1 - Post-assessment

Instructions:

1. Complete the rating scale on the etching of a nameplate or the production of a locker organizer and screen printing.
2. Have the instructor complete the rating scale form and discuss any discrepancies between the two assessments.
3. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #1 - Post-test -- Rating Form (First Week Activity)

Course: Introduction to Materials & Processing Technology **Date:** ________

Tam# 7 **Title:** First Week Activity

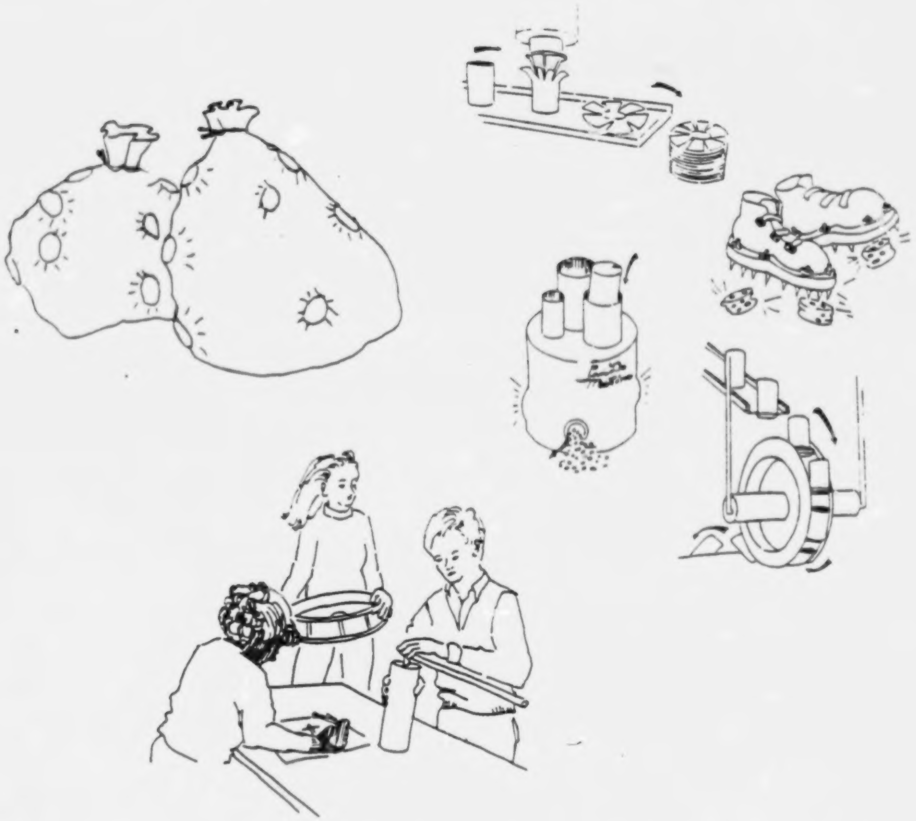
Student Name: ____

	Performance Rating
	Poor **Excellent**
TASK	**1 2 3 4 5**
Etching:	
1. Was the metal successfully cleaned with powder and water?	__:__:__:__:__
2. Did the resist adhere to metal?	__:__:__:__:__
3. Was the design successfully transferred to the project?	__:__:__:__:__
4. Was the design successfully etched into the project?	__:__:__:__:__
5. Was the project cleaned of acid, neutralized and washed with water?	__:__:__:__:__
6. Was safety observed?	__:__:__:__:__
7. Was clean-up done properly?	__:__:__:__:__
Sample Line Production:	
1. Were the blanks cut to size successfully?	__:__:__:__:__
2. Were the mounting holes drilled properly?	__:__:__:__:__
3. Were all edges sanded and contoured properly?	__:__:__:__:__
4. Was the locker organizer finished well?	__:__:__:__:__
5. Was the name plate mounted to the locker, using foam tape successfully?	__:__:__:__:__
Screen Printing:	
1. Did you produce the design you wanted on the silk screen successfully?	__:__:__:__:__
2. Did you figure out how to get the design on your T-shirt successfully, using either heat transfer or silk screen method?	__:__:__:__:__
3. Was the application of the image to the T-shirt done properly?	__:__:__:__:__
4. Did you prepare the T-shirt for printing successfully?	__:__:__:__:__
5. Was the ink applied to the screen away from the screen opening?	__:__:__:__:__
6. Was the proper squeegee selected?	__:__:__:__:__
7. Did you lower the frame onto the T-shirt successfully?	__:__:__:__:__
8. Did you squeegee ink across the artwork properly?	__:__:__:__:__
Field Trip:	
1. Did you participate in planning the trip?	__:__:__:__:__
2. Did you record your observations during tour?	__:__:__:__:__
3. Did you participate in trip discussions?	__:__:__:__:__
	Total:____

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module # 2

Problem Solving



TAM #2 : Problem Solving

Instructor Component

Activity Objective: The purpose of this activity is to systematically develop student skills with a variety of processes involved in creative thinking and technological problem solving.

Activity Competencies: By completing this TAM, the student will be able to:

1. Solve materials and processing technology problems through problem solving, creative thinking and decision-making processes. [6,V]
2. Employ individual and group problem-solving processes to arrive at alternative solutions, to assess, and subsequently to implement, solutions to assigned technological problems. [2, V]
3. Design a technological system, using existing and/or newly developed components and/or building blocks, to meet an assigned set of design specifications. [2,VI]
4. Report technological information using graphics, charts, tabular and textual presentations in printed media or electronic forms. [2,III]

Module Instructions

Introduction:

This activity module is designed to teach students to solve problems through creative thinking, the development of ideas into prototypes and subsequent production activities. This module can be incorporated into normal classroom activities.or it can be used as a stand-alone activity. The activities in this module include pre-testing, post-testing, demonstration of procedures, and student problem solving work.

Safety Considerations:

Double check to be sure that all safety rules and regulations are being observed when students are performing activities in this module. For example, are students wearing eye protection when making their vehicles?

Needed Materials:

1. **Supplies**

• Commercially produced metric Dragster Kit or equivalent	• Tape
• Paint	• Pencil
• glue	• Abrasive paper
	• Metric grid paper

2. **Equipment**

• Machines drill press band saw or jig saw	• Ballpeen hammer • Pliers • 30 cm rule (standard 12 inch ruler)
• Files	• Coping saw
• Chisel	• Sanding block
• Scratch awl	

3. **Handouts**

   A. Student component of TAM # 2.

   B. Problem-solving handouts (to be developed).

   C. Dragster kit official entry form.

4. **Instructional Resources**

   A. Film (scan media sources, Section III, part 4 for appropriate items)

   B. Books and Articles

      Darrow, D. & Pine, D. (1980). Production. Des Moines, IA: Iowa Department of Public Instruction. pp. 191-205.

      Gourley, J. T. & Micklus, S. C. (1984). Problems! problems! problems! Discussions and activities designed to enhance creativity. Glassboro, NJ: Creative Competitions. pp. 6-33.

      Oliver, A. T. & Bradley, E. (1987). OM-AHA! Problems to develop creative thinking skills. Glassboro, NJ: Creative Competitions. pp. 7-23.

      Owen, E. (1987). Problem solving candle carrier. Muncie, IN: Ball State University. pp. 1-6.

      Wright, T. (1986). Evaluating product ideas. Muncie, IN: Ball State University. pp. 1-3.

      Wright, T. (1986). Improving ideas through brainstorming. Muncie, IN: Ball State University. pp. 1-6.

      Wright, T. (1986). Modeling product solutions. Muncie, IN: Ball State University. pp. 1-7.

   C. A guest lecturer such as representatives of the state's Odyssey of the Mind competition, the Missouri Science Olympiad, etc.

Management/Logistics:

1. **Related TAMS**

   This TAM is related to all TAMS (1-15). Because both you, the instructor and your students can use problem solving to support your work in any other TAM, the process is appropriate anywhere.

2. **Evaluation/Grading**

   A. Evaluate the quality of the design/sketch and production engineering work done for the prototype.

   B. The crafted quality and performance of the working model.

   C. Pre- and post-tests taken by students.

3. **Suggested Schedule/Time**

   The suggested completion time for this module is three weeks.

Key Instructional Suggestions:

1. **Safety**

   The instructor should double check to be sure that all potential safety problems are addressed.

2. **Motivation**

   Take a field trip to any manufacturing plant that includes a significant design staff. Note that the problem assigned should be changed as needed to interest the class/individual. Other ideas might include: can crushers, bottle openers, locker organizers, school signs, etc.

3. **Prerequisite Information**

   None

4. **Demonstrations**

   Work out a case study of a problem-solving activity that allows students to see the action/result at each step of the process.

5. **Reinforcement**

   A. Present the class with a film (e.g., the Odyssey of the Mind video tape) related to the activity module, i.e., problem solving.

   B. Schedule a field trip to a manufacturing plant's design department.

6. Attitudes

Point out that students should never allow themselves to be discouraged when problems arise. Highlight the experiences of great inventors such as Marie Currie, Amelia Earhart, Thomas Edison, Henry Ford, Margaret Knight, Oppenheimer etc. Encourage students to watch a related television program such as Biography! or to read a book on the topic.

7. Remediation/Enrichment

A. Remediation: Assign a second design problem that is simpler than the initial assignment to students who are having problems.

B. Enrichment: Be prepared with high level "challenge" tasks for advanced students. e.g., design an information communication system using non-visible light. Have students participate in future problem solving bowl or science olympiads.

8. Summary & Review

A. Summarize and review the following steps in the problem-solving process:

1. Identifying the Problem
2. Gathering information
3. Defining the problem
4. Developing solution model
5. Analyzing solution model
6. Implementing solution
7. Testing the model

9. Review Questions & Answers *(Answers are in italics)*

These are test questions to orally review with students.

1. Creativity is a: *knowledge-producing thinking skill.*
2. The first step in creativity is to help the student: *think* .
3. The divergent thinker has the ability to examine an issue from a: *variety of viewpoints.*
4. The first step to developing divergent thinking is to allow students the freedom to use their: *imaginations* .
5. The advantage of brainstorming is that it separates: a. *problem finders* from b. *problem solvers.*

TAM #2 - Pre-test (Problem Solving)

Instructions**:** Circle the correct answers

1. A vital factor in successfully solving problems is efficiency in: [M & P,T#2,6,V]
    a. Brainstorming
    b. Alternative solutions
    c. Communications
    d. Evaluation

2. To help us understand a problem better, it is necessary to: [M & P,T#2,2,VI]
    a. Limit costs
    b. Break the problem down into simpler parts
    c. Limit size, weight and shape problems
    d. Limit operating conditions

3. Brainstorming involves groups of people: [M & P,T#2,2,IV]
    a. Identifying appropriate criteria
    b. Producing ideas
    c. Searching for information
    d. Analyzing information

TAM #2 - Post-test (Problem Solving)

Course: Introduction to Materials & Processing Technology **Date:** ____________

Tam#: 2 **Title:** Problem-solving Activity

Student Name: ______________________________

	TASK	**Performance Rating** **Poor** **Excellent** **1 2 3 4 5**
1.	Began with a good idea.	__:__:__:__:__
2.	Created list of ideas.	__:__:__:__:__
3.	Followed the problem-solving process.	__:__:__:__:__
4.	Used materials effectively.	__:__:__:__:__
5.	Set up time and work responsibilities.	__:__:__:__:__
6.	Attempted non-traditional solutions.	__:__:__:__:__
		Total:__

TAM #2 - Test Keys (Problem Solving)

TAM #2 - Pre-test Answers

1. c 2. b 3. b

TAM #2 - Post-test Answers

A rating scale form is used as a post-test. A rating of 75% of the applicable items is an appropriate minimum.

TAM #2 : Problem Solving

Student Component

Introduction:

People are different from all other species. Men and women are unique because they have a greater intellectual capacity than any other species of life. They are able to think, create, design and use tools. This important set of capabilities is what allows men and women to develop and use technology. This module will involve you in creative problem solving by developing your individual creativity and intellectual capacity.

Competencies: Following the completion of this TAM you will be able to:

1. Solve materials and processing technology problems through problem solving, creative thinking and decision-making processes. [6,V]
2. Employ individual and group problem-solving processes to arrive at alternative solutions, to assess, and subsequently to implement, solutions to assigned technological problems. [2, V]
3. Design a technological system, using existing and/or newly developed components and/or building blocks, to meet an assigned set of design specifications. [2,VI]
4. Report technological information using graphics, charts, tabular and textual presentations in printed media or electronic forms. [2,III]

Module Overview:

This module contains two activities: 1. Designing and building a "Land Speed Record Breaking Vehicle" (LSRBV) and/or Building a "Mouse Trap Vehicle" (MTV) with the objective being to travel the most distance in the least amount of time. You are required to study and identify the design limitations. In addition, you must know factors that will affect the design of the vehicle, then build and test a prototype of an LSRBV.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 --Problem Solving.: Land speed record breaking vehicle
4. Do Activity #2 --Problem Solving.: Mouse trap vehicle
5. Design and engineer a metric LSRBV and/or MTV. Build a prototype of your design. Report your design solutions and problems in a technical report.
6. Complete an official entry form.
7. Compete in a race or contest.
8. Record your race times (or appropriate performance) and calculate your scaled speeds.
9. Analyze how you can improve the performance of your LSRBV and or MTV. What criteria would you like to change?

Key Information:

1. **Class Presentations**

The Problem-solving Process

A. Identify problem
  - •Analyze problem
  - •Analyze the problem's context
  - •Define & clarify the problem

B. Establish solution criteria
  - •Identify appropriate criteria
  - •Identify constraints and limitations
  - •Weight criteria according to the nature of the problem
  - •Develop a design brief

C. Assemble pertinent information
  - •Search for information
  - •Analyze information
  - •Synthesize appropriate information

D. Formulate alternative solutions
  - •Brainstorming
  - •Remove barriers to "creative juices"

E. Evaluate alternatives
  - •Apply solution criteria
  - •Select optimum solution

F. Implement prototype solution
  - •Develop prototype solution
  - •Produce drawings
  - •Theory test
  - •Plan implementation of solution
  - •Implement prototype solution
  - •Evaluate prototype solution in operation

G. Refine solution
  - •Communicate the solution
  - •Refine the prototype solution
  - •Implement the refined solution
  - •Monitor the solution on an appropriate basis

2. Demonstrations (Creative exercises to develop the mind)

Complete the following exercises:

1. Using only squares, and only the provided space, draw as many things as you can think of.

2. Using circles, sketch/design whatever you can think of.

3. Design a crimped-cap bottle opener, following these guidelines:
   - a. The device is to be fixed to a wall.
   - b. The device should not cost more than $5.00.
   - c. The device is to be hygienic (easy to clean, etc.)
   - d. The device must be safe during production and use.

3. Safety

Follow the normal laboratory safety procedures when performing your activities in this module.

4. Personal Activity

As your homework, you are encouraged to read The Technology Teacher, Industrial Education, School Shop, TIES Journal and/or other materials contain information related to problem solving.

Owen, E. (1987). Problem-solving candle carrier. Muncie, IN: Ball State University. pp. 1-6.

Glossary:

Brainstorming	A process that involves freely creating ideas to solve problems by accepting all ideas as possible solutions.
Creativity	Having new, innovative and original ideas.
Design	To create a plan or proposal by use of sketches, drawings, etc.
Evaluation Form	An instrument used to determine a student's level of performance.
Idea	A concept or thought achieved through the use of mental processes.
Invention	The process of trying to create, design and/or develop ideas into concrete models.
Inventor	A person who creates, designs and develops solutions to problems
Problem Solving	The process of developing a workable solution(s) to a specific situation.
Patent	A government document that is used to protect one's invention from being copied by others for their own monetary gain without the inventor's permission (Gourley & Micklus, 1984).
Scaled Speed	The speed that a model would be traveling if its actual speed were scaled up proportionally to its actual size. For example, if a model, that is 1/50 tieth the size of a real car, .travels at 8 actual miles an hour (704 feet per minute), then its scaled speed would be 50 x 8 or 400 miles per hour.

Needed Materials:

1. **Supplies**
   - Commercially produced metric dragster kit or equivalent
   - Paint
   - Glue
   - Tape
   - Pencil
   - Abrasive paper
   - Metric grid paper
2. **Tools & Equipment**
   - Machines
     - drill press
     - band saw or jig saw
   - Files
   - Chisel
   - Scratch awl
   - Ballpeen hammer
   - Pliers
   - 30 cm rule (standard 12 inch ruler)
   - Coping saw
   - Sanding block
3. **Handouts/Instructional Resources**
   - Problem-solving observation form
   - Dragster Kit Official Entry Form.

Problem-solving Observation Form

Session: ____________ Class: ____________ Group/Ind: ____________

Date: ____________ Time: ____________ Observer: ____________

Rate the extent to which the group/individual has implemented each major step of the problem-solving process. Use each step's components as indicators of accomplishment.

1. **Identify problem** .... N/A | Weak | Somewhat | Good | Superior
   - Analyze problem .... N/A | OK
   - Analyze the problem's context .... N/A | OK
   - Define & clarify the problem .... N/A | OK
2. **Establish solution criteria** .... N/A | Weak | Somewhat | Good | Superior
   - identify appropriate criteria .... N/A | OK
   - Identify constraints and limitations ... N/A | OK
   - Weight criteria according to the nature of the problem .... N/A | OK
   - Develop a design brief .... N/A | OK
3. **Assemble pertinent information** ..... N/A | Weak | Somewhat | Good | Superior
   - Search for information .... N/A | OK
   - Analyze information .... N/A | OK
   - Synthesize appropriate information .... N/A | OK
4. **Formulate alternative solutions** ...... N/A | Weak | Somewhat | Good | Superior
   - Brainstorming .... N/A | OK
   - Remove barriers to creative juices N/A | OK
5. **Evaluate alternatives** .... N/A | Weak | Somewhat | Good | Superior
   - Apply solution criteria .... N/A | OK
   - select optimum solution .... N/A | OK
6. **Implement prototype solution** .... N/A | Weak | Somewhat | Good | Superior
   - Develop prototype solution .... N/A | OK
     - Produce drawings
     - Theory testing
   - Plan implementation of solution .. N/A | OK
   - Implement prototype solution ...... N/A | OK
   - Evaluate prototype solution in use ... N/A | OK
7. **Refine solution** .... N/A | Weak | Somewhat | Good | Superior
   - communicate the solution .... N/A | OK
   - Refine the prototype solution ...... N/A | OK
   - Implement the refined solution .... N/A | OK
   - Monitor the solution appropriately N/A | OK

Land Speed Record Breaking Vehicle (LSRBV)

Official Entry Form

1. Student name ______________________________
2. Car name ______________________________
3. Car color ______________________________
4. Engine weight ______________________________
5. Car length ______________________________
6. Car width (maximum) ______________
7. Car height (maximum) ______________
8. Road clearance (road to bottom of car) ______________
9. Diameter of axle ______________
10. Bearing material ______________
11. Size of wheel (outside diameter) ______________
12. Model speed (estimated) ______________
13. Size of engine (length and diameter) ______________
14. Length of track (10.1M, 14.1M, 16.2M) ______________
15. Sketch of your car on fresh paper (side view) attached to this page

Signed ______________________________

LSRBV Checklist

A. Entry fee paid __________
B. Safety inspected __________
C. Starting number __________
D. Judges' initials __________

____

____

(A) Scaled Speed	(B) Actual Speed
____________________	______________
____________________	______________
____________________	______________

(Adapted from Darrow, D. & Pine, D. pp. 193-4, 1980)

Activity #1 - Land Speed Record Breaking Vehicle: Plan of Procedure

1. Identify problem

   Design and build a land speed record breaking vehicle
   It should reach speeds not less than 500 km/h
   It should reach for the record of 1440 km/h

2. Establish solution criteria

   Brainstorm
   Identify the limits
   Identify constraints
   Identify variables

3. Assemble pertinent information

   Body structure
   Axle
   Bearing
   Wheel performance
   Steering system

4. Develop prototype solutions

   Construct a prototype (model) from polystyrene foam

5. Analyze prototype solutions

   Test bearing, axle, wheel assembly
   Experiment with weight to speed ratio

6. Implement prototype solution

   Begin construction of the vehicle if you have an acceptable solution and you are satisfied with the prototype.

7. Refine solution

   Monitor for new problems.
   Test LSRBV on a prescribed course: (10.1m, 14.1m or 16.2m). If it meets your requirements, you have completed the activity successfully. If you did not meet the requirements, make necessary changes.
   Test the prototype again.

Activity #2 - Mouse Trap Vehicle: Plan of Procedure

1. Design and build a better Mouse Trap Vehicle (MTV) that travels the longest distance in least amount of time.

The largest Q-factor wins $$Q = \frac{\text{Distance in meters}}{\text{Time in seconds}}$$

2. Establish solution criteria.
   a. identify appropriate criteria.
   b. Identify constraints and limitations.
   c. Weight criteria according to the nature of the problem.

3. Assemble pertinent information.
   a. Structure of the body.
   b. Materials wheels
   c. Bearings.

4. Develop/Formulate alternative solutions.- Build a prototype/model.

5. Evaluate alternatives - Test for wheels, bearings, etc.

6. Implement prototype solution - Begin building the vehicle, if you have an acceptable solution and you are satisfied with the prototype.

7. Refine solution
   a. Monitor for new problems
   b. Test MTV. If it meets your requirements you have completed the activity successfully. If you did not meet the requirements make necessary changes.
   c. Test prototype again.

TAM #2 - Summary

1. Review & Summary Activities

Human beings have always been technologists. Because the need to cope with the environment faces us all, this challenge has become the center of technological activity. Meeting this challenge usually depends on our success in using the problem-solving process. It arises from your needs and applying available knowledge and resources, trying to satisfy your needs as efficient as possible.

Therefore, problem-solving is an important part of technological activity and this TAM is a basic element of all technological courses.
(Adopted from Oliver and Boyd, 1987)

2. Review Questions -- Test yourself!

1. Explain the factors that determine a car's speed and why they determine it.
2. Why did you design your dragster kit or MTV the way you did?
3. Define and explain the concepts associated with the steps of problem solving.
4. Describe the categories of problem-solving techniques and their primary characteristics.

TAM #2 - Post-assessment

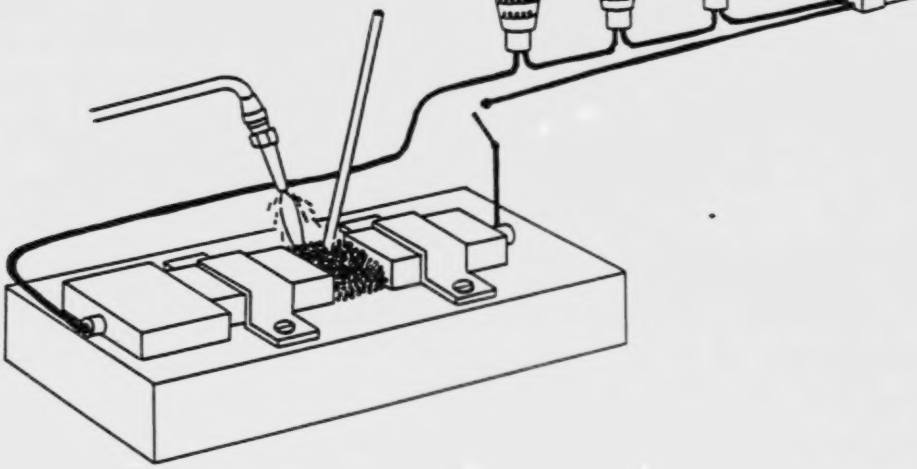
Instructions:

1. Complete the observation form about the problem-solving process that you followed.
2. Have the instructor complete the evaluation and discuss discrepancies between the two assessments.
3. Complete the post-test for TAM #2.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	Introduction to Materials and Processing Technology

Technology Activity Module #3

Glass Fabrication & Processing



Instructor Component

Activity Objective: The purpose of this activity is to expose the student to a range of processes which may be performed in the manufacture and processing of glass. These processes include: transformation of raw materials, measurement, design, cutting, abrading, extrusion and soldering.

Activity Competencies: By completing this TAM, the student will be able to:

1. Describe and give examples of the categories of glass properties and characteristics.[3,I]
2. Identify the range of ceramic materials called glass. [3,I]
3. Provide some key examples of the relationship between the molecular/crystalline structure of glass and its properties. [3,III]
4. Trace the path of glass from its extraction, through its processing into industrial standard stock, to the finished product. [3,V]
5. Process a variety of appropriate ceramic materials using separating, combining, forming and conditioning methods. [3,I]
6. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII]
7. Distinguish among torsional, impact, tensile and fatigue strength. [3,III,]

Module Instructions

Introduction:

This activity is designed to combine fabrication, design and processing methods as applied to glass. It is suggested that the activity be integrated into appropriate classroom presentations of ceramic materials and processing technology. The proposed activities include a pre-test, safety instruction and demonstration of processes and procedures, and two hands-on glass processing procedures.

Safety Considerations:

The safe handling of glass and soldering materials demand that special attention be given to appropriate safety instruction, including apparel and safe handling practices. Gloves and safety glasses are required at all times.

Needed Materials:

1. Supplies

Glass Making Supplies

- very fine, white sand, sifted
- calcium oxide
- anhydrous sodium carbonate

Leaded Glass Fabrication Supplies

- emery cloth
- aluminum oxide sandpaper
- fine steel wool (00)
- assorted glass (1/8" thickness)
- 30 ga. copper foil
- 50/50 solder
- soldering flux
- beeswax
- acid brush
- grease pencil
- paper

2. Equipment

Miniature Furnace Materials

- fire brick
- (2) graphite blocks (1/2 x 1 x 2)
- (3) 10 Amp heater cones
- connecting wiring
- porcelain probe
- cord and plug switch
- dark goggles

Leaded Glass Fabrication Materials

- 150-300 watt soldering iron
- scissors
- glass cutter
- pliers
- goggles (or side shielded eyeglasses)
- gloves
- dies for forming copper foil

3. Handouts

A. Student component of TAM #3

B. Safety handout (provided in student component)

4. Instructional Resources

A. Film (select an appropriate title from Modern Talking Pictures, a glass company like Dow Corning, and or the National Glass Association. See Section III, part 7)

B. Books and Articles

__________. (1973). Industrial arts and the challenge of an urban society. Washington, D.C.: National Education Association. American Industrial Arts Association. p. 265-268.

_________. (1977). Industrial arts and space technology: Conference proceedings. Washington D.C.: National Education Association Association. American Industrial Arts Association. p.297-303.

Ebert, S. (nd.). Safety education handbook. Topeka, KS: Kansas State Department of Education. vol 1. pp. 238-239.

Satterberg, J. (1975). Lightweight leaded glass lamp. Industrial Education. p.64-66.

C. A guest lecturer such as a glass blower, glass fabricator or optician handicrafter.

Management/Logistics:

1. Related TAMS

This TAM is independent of others in this cause.

2. Evaluation/Grading

A. Evaluate design/sketch based on form, function and cost of product.

B. The crafted quality of a working product.

C. Evaluate pre- and post-tests taken by students.

3. Suggested Schedule/Time

The time suggested for this TAM is one to two weeks.

4. Instructional Management

Be sure all student are properly grouped when using the minature furnace.

Key Instructional Suggestions:

1. Safety

The concerns here are:

A. Electric shocks

B. Heat

C. Handling of molten glass

D. How to cool glass correctly

2. Motivation

Use video from Dow Corning Glass works.

Visit glass manufacture or working facility. (Field trip)

3. Prerequisite Information

None

4. Demonstrations

A. Making glass with a miniature glass furnace.

B. Cutting glass with a wheel cutter.

C. Sanding all cut edges.

5. Reinforcement

Consider establishing an enterprise to sell glass products.

6. Attitudes

A. General safety attitudes.

B. Housekeeping and general cleanliness are very important.

C. Encourage students to be receptive to materials other than the traditional wood and metal.

7. Remediation/Enrichment

A. Remediation: Show video on glass making -- Dow Corning and/or do activities with different glass recipe

B. Enrichment: Explore glass enamels, e.g., translucent, enamel and other glass related processes.

8. Summary & Review

In this TAM, we have made and fabricated glass. We have also processed materials by measuring, designing, cutting, abrading, extrusion and soldering. With the experience acquired during the activities you performed in making and processing of glass, you can transfer these skills to other areas of manufacturing and processing technology. The following are to be reviewed:

- How to mix and prepare a charge
- How to make glass
- How to cut glass
- When and how to sand edges
- How to extrude foil
- Rimming glass pieces
- Running a bead of solder along joints

9. **Review Questions & Answers** *(Answers are in italics)*

A. The alloy of tin and lead is called: *solder.*

B. Functional considerations, aesthetic considerations and concern for proportion are the key elements in: *product design.*

C. When extruding foil, the foil has to be pulled through 1) *die #1* and 2) *die #2.*

D. Before solder is applied to joints, the mating surfaces should be coated with: *paste flux.*

E. To polish cut edges of glass, one should use: *abrasive paper.*

Date: ____________ Class: ____________ Name: ____________

TAM #3 - Pre-test (Glass Fabrication & Processing)

Instructions: Circle the letter that correctly completes the sentence.

1. Glass is classified as: [M & P, T#3, 3, I]
   a. an organic material.
   b. a ceramic material.
   c. a metallic polymer.

2. In terms of mechanical qualities, glass.....[M & P, T#3, 3, A]
   a. has good fatigue strength.
   b. has good compressive but poor impact strength.
   c. has extremely low tensile strength.
   d. is only moderately bendable.

3. The term extrusion means: [M & P, T#3, 3, I]
   a. hammering a metal into a given shape.
   b. a form of heat treatment.
   c. combining metals into a new alloy.
   d. reshaping by forcing through a die.

4. Correct safety procedures for glass handing include: [M & P, T#3, 3, VII]
   a. using safety glasses.
   b. wearing gloves.
   c. being careful.
   d. all of the above.

5. Glass is made by: [M & P, T#3, 3, I]
   a. heating silicates to very high temperatures.
   b. a chemical reaction between aluminum and argon gas.
   c. crushing and combining iron oxide with aluminum.
   d. extraction from the earth in its natural form.

6. Glass cutting in the school laboratory usually involves: [M & P, T#3, 3, V]
   a. a rotating carbide-tipped saw blade.
   b. scoring the surface and then breaking the glass.
   c. a very intense application of a laser beam.
   d. the use of a high speed abrasive wheel.

7. Which is not a characteristic of glass? [M & P, T#3, 3, I]
   a. chemical resistance.
   b. translucence.
   c. stiffness.
   d. high insulation value.

8. In fabricating with solder and glass: [M & P, T#3, 3, VIII]
   a. care must be taken not to melt the glass.
   b. the glass must be in a molten state for lead to adhere.
   c. one must consider heat-related contraction and expansion.
   d. remember that glass and lead melt at nearly the same temperature.

TAM #3 - Test Keys (Glass Fabrication & Processing)

TAM #3 - Pre-test Answers

1. b   2. d   3. d   4. d   5. d

6. b   7. d   8. a

TAM #3 - Post-test Answers

A rating scale form is used as a post-test.

Note: TAM #3 post-test is provided in student component.

TAM #3: Glass Fabrication & Processing

Student Component

Introduction:

Glass is an extremely useful and versatile industrial material. When formed into various shapes and framed with other materials, its usefulness extends from the home to skyscrapers to outer space and beyond. This module will involve you in the process of making glass. You will also be able to create a product of your own design using glass in combination with other materials. Many of the principles, materials and tools that you will use in this activity are used daily in industry.

Competencies: Following the completion of this TAM, you will be able to:

1. Describe and give examples of the categories of glass properties and characteristics.[3,I]
2. Identify the range of ceramic materials called glass. [3,I]
3. Provide some key examples of the relationship between the molecular/crystalline structure of glass and its properties. [3,III]
4. Trace the path of glass from its extraction, through its processing into industrial standard stock, to the finished product. [3,V]
5. Process a variety of appropriate ceramic materials using separating, combining, forming and conditioning methods. [3,VI]
6. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII]
7. Distinguish among torsional, impact, tensile and fatigue strength. [3,III,A]

Module Overview:

This Module contains the following two activities:

1. Glass making with the miniature glass furnace.
2. Glass fabrication.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure
2. Complete the pre-test given by your instructor.
3. Do Activity #1 -- Glass Making.
4. Do Activity #2 -- Leaded Glass Fabrication.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. Class Presentations

- The distinction between glass and clay
- The importance of the development of glass
- The variety of silicon-based raw materials and processed materials
- Identify the source of each material in its natural environment

2. Demonstrations

- Glass making with miniature glass furnace
- Glass fabrication

3. Safety

Major concerns:

- Electric furnaces
- Dark glasses #5
- White sand
- Calcium oxide
- Anhydrous sodium carbonate
- Glass rod
- Grease Pencil
- Dies
- Solder

4. Personal Activity

As your homework, you should read about glassmaking, glazing and/or architectural trade journals that contain information related to this TAM. Also read the assigned sections in the following books before starting on this activity:

______. (1977). Industrial arts and space technology: Conference proceedings. Washington D.C.: National Education Association & American Industrial Arts Association. p.297-303.

Alternatively visit your local hardware store and discuss glass cutting and polishing processes with their crafts-person.

Glossary:

Glass	A ceramic material, usually transparent, made by the fusing silica.
Solder	An alloy of tin and lead.
Extrusion	A process of reshaping by forcing through a die.
Anhydrous Sodium Carbonate	A gaseous liquid.
Ceramics	Making a product from a nonmetalic mineral by melting its silicates to hold their shape.
Etching	A process of applying a reactive solution to the surface of a metal to form a design.
Translucent	Permitting the passage of light or free from disguise or falseness.
Perimeter	The boundary of a closed plane figure, i.e., the circumference.

Needed Materials:

1. Supplies

Glass Making Supplies

- very fine, white sand, sifted
- calcium oxide
- anhydrous sodium carbonate

Leaded Glass Fabrication Supplies

- emery cloth
- aluminum oxide sandpaper
- fine steel wool (00)
- assorted glass (1/8" thickness)
- 30 ga. copper foil
- 50/50 solder
- soldering flux
- beeswax
- acid brush
- grease pencil
- paper

2. Equipment

Miniature Furnace Materials

- fire brick
- (2) graphite blocks (1/2 x 1 x 2)
- (3) 10 Amp heater cones
- connecting wiring
- porcelain probe
- cord and plug switch
- dark goggles

Leaded Glass Fabrication Materials

- 150-300 watt soldering iron
- scissors
- glass cutter
- pliers
- goggles (or side shielded eyeglasses)
- gloves
- dies for forming copper foil

3. Handouts/Instructional Resources

Safety handout

TAM #3 - Safety Handout

The following safety rules and regulations are designed specifically to help you perform the activities in this TAM safely. They are as follows:

1. When breaking glass with hand tool(s), wear your goggles to protect your eyes from flying pieces of glass.
2. While working with glass in the laboratory, clean the bench and floor from time to time to avoid any type of hand or foot injury.
3. Use soft leather gloves when working around with shop glass, cut-edges, etc.
4. Be very careful when picking up and/or putting down glass. Do not slide your hands against the glass edges.
5. Make sure you always put all glass scraps in a dust bin. Avoid putting scraps in polythene bags for disposal.
6. Whenever possible, use abrasive paper to smooth glass. Make sure you back the abrasive paper with wood to avoid an accident.
7. When working with large sheets of glass, you should always use a flat table to avoid glass breakage, which can cause accidents.

Selecting Glass Doors

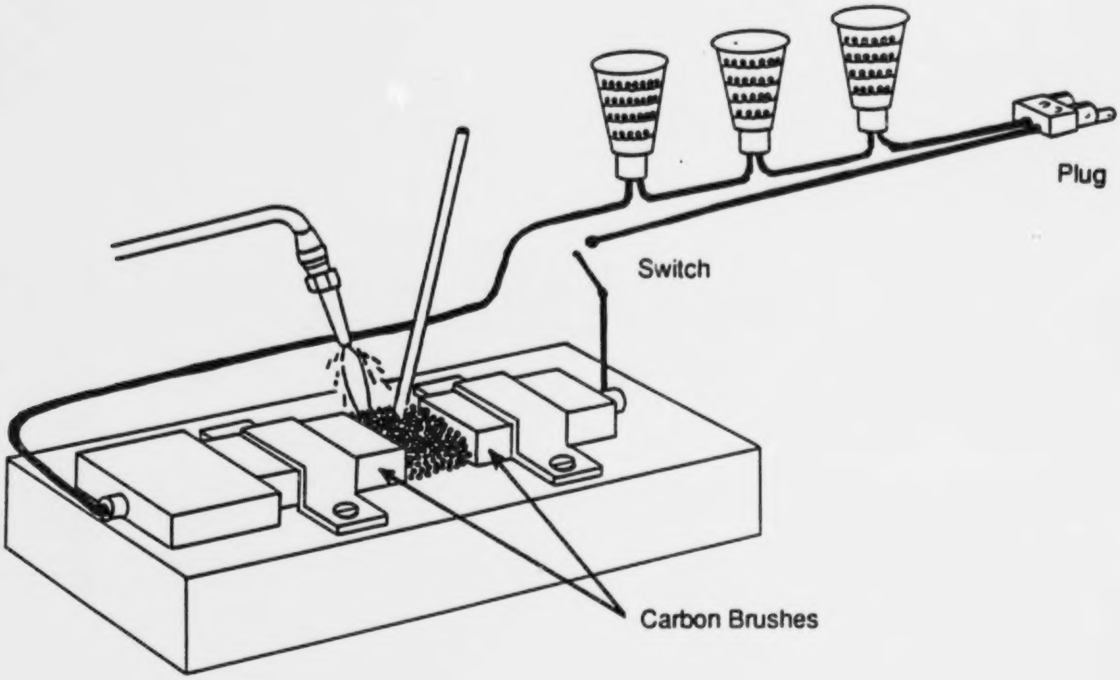
Install safety glazing when buying or replacing doors or panels in the home. The four types of safety glazing materials are:

1. Tempered glass -- when broken, it crumbles into small pieces, which minimize the chance of serious personal injury.
2. Laminated glass -- is resistant to breakage. However, if it does break, the pieces generally stick to the plastic and do not scatter.
3. Wire glass -- when it breaks, the larger pieces are usually held together by the wire.
4. Rigid plastic -- made from one or more layers of plastic heated together. It sometimes contains reinforcement materials to make it stronger.

(Adopted from Ebert, n.d., vol 1. pp. 238-239)

Activity #1 -- Glass Making: Plan of Procedure

1. Observe instructor's demonstration of glass making with the miniature glass furnace.



2. Prepare a "charge" for the electric furnace by weighing the following materials on a scale:

   1.2 oz. white sand

   0.4 oz. calcium oxide

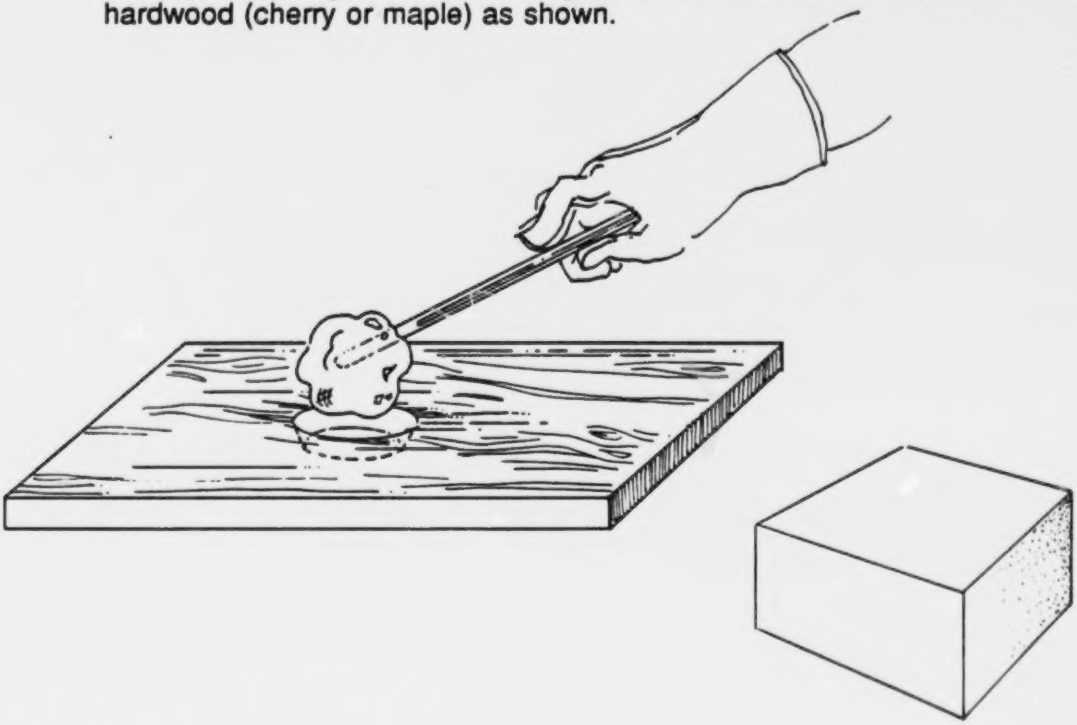
   0.4 oz. anhydrous sodium carbonate

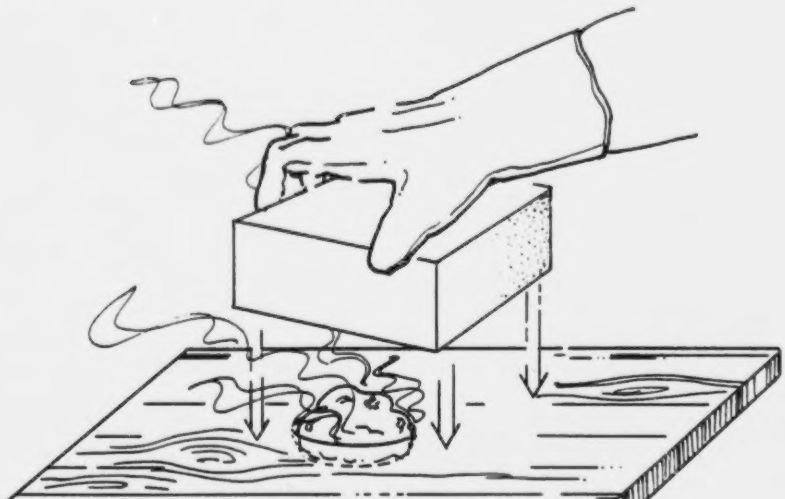
3. Thoroughly mix the "charge" in a paper cup then pour it between the furnace electrodes. Be sure the power is off at this time.

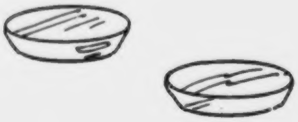
4. Put on dark glasses and turn the electrical power to activate the furnace. Push the brushes as close together as possible and then heat the change with the torch flame.

5. Agitate the mixture occasionally with the porcelain probe to insure adequate mixture. When the arc is well established, gradually spread the brushes further apart and shut off the torch.

6. Once the entire mixture has melted, remove the glass with the porcelain probe. Quickly take the globule of molten glass and press it into a mold carved into hardwood (cherry or maple) as shown.

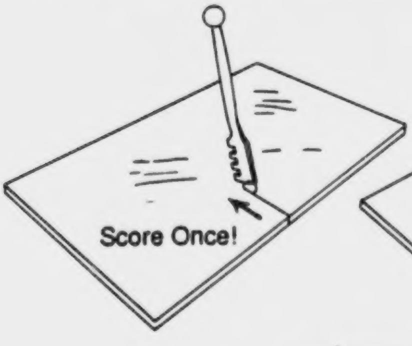


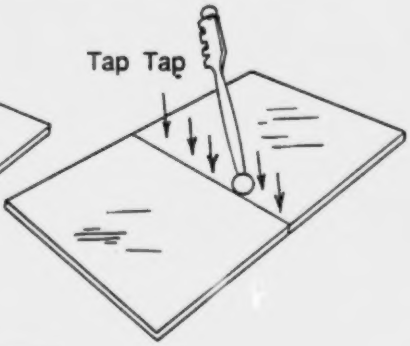


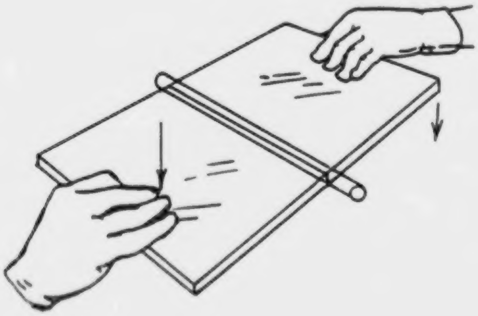


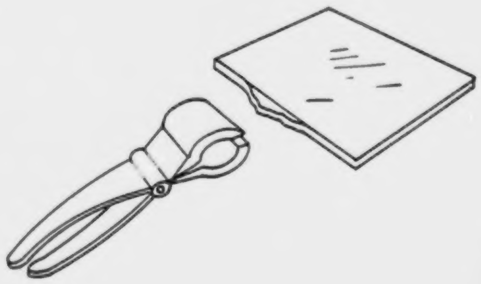
Activity #2 – Leaded Glass Fabrication: Plan of Procedure

1. Develop a design for a leaded glass or mirror product. Possibilities include:
   a. stained glass entry door panel(s).
   b. picture frame.
   c. inset panel for furniture (china hutch door glass, grandfather clock glass inset, etc.).
   d. a decorative mirror.
2. Construct an "exact dimension" paper pattern of the design.
3. Transfer the pattern dimensions to the glass with a grease pencil. Cut the glass to size(s) with a glass cutter.
4. Score the glass using a wheel cutter. Then do the the following:
   a. tap along the opposite side of the score.
   b. place the score carefully over a rod and press down to snap the glass (wear gloves!).
   c. don't score glass more than once.
5. Use grozing pliers to nibble off any larger protrusions.

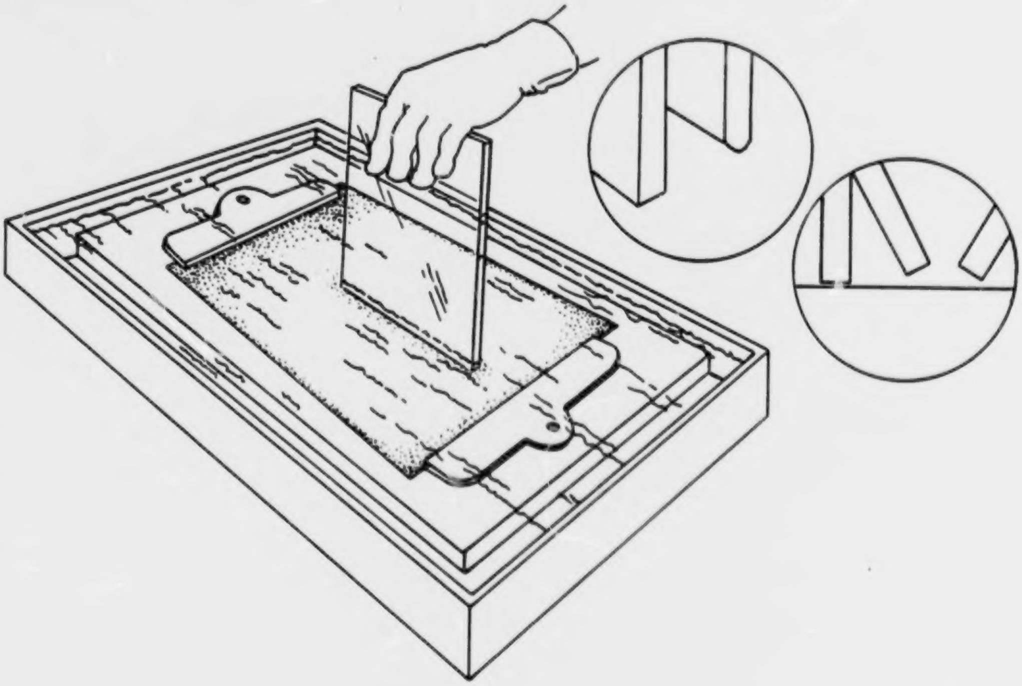




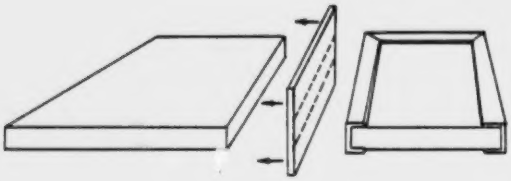


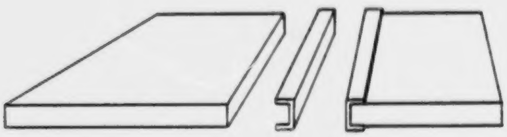


6. Sand all cut edges with aluminum oxide sandpaper. A home-made jig is shown. It uses two clipboard clips, mounted on a sheet of acrylic plastic, to hold a section of wet and dry abrasive paper in place. Place this jig in a lager plastic water-filled tray to produce a smoother edge. Rock the glass to round off all sharp edges.



7. Cut lengths of copper foil into 3/8" wide strips with heavy duty scissors.
8. Extrude (pull) the foil through two channel-shaped dies with pliers. Use beeswax to lubricate the copper and help through the dies.
9. Measure the perimeter of each piece of glass. Cut a length of extruded foil to each length plus 1/4" for overlapping joint.
10. Rim each piece of glass with the prepared length of foil, notching corners for fit.



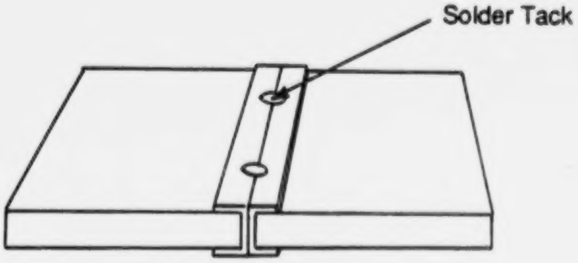


11. Thoroughly brush the overlapping joint portion of the copper with fine steel wool to clean it.

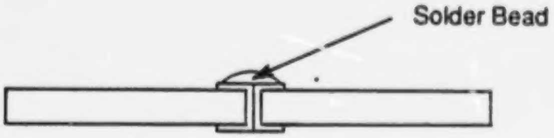
12. Brush paste flux onto joints and apply solid core solder with a 150-300 watts chisel-tipped soldering iron. Try to create a thin film over all the foil.

13. Assemble individually rimmed glass sections into the completed design configuration. (This assembly can be secured with a clamp or fixture.)

14. Tack individual pieces together at enough points to secure the assembly.



15. Run a bead of solder along all joints (finished side only).



16. Polish all joints with fine steel wool.

TAM #3 -- Summary

1. Review & Summary Activities

Ceramic materials are usually formed into many kinds of functional products using shaping devices. Glass is one of those materials.

This TAM taught you how to make glass and also fabricate it. In addition to the activities you performed in this TAM, you can use glass materials as a part of many other projects. Glass can be drawn into tubes, sheets, rods and fibres to meet many of your everyday uses.

Therefore, what this TAM teaches you in terms of importance and experience is second to none. If you utilize the knowledge and experience acquired effectively, you will benefit and enjoy it a lot.

2. Review Questions - Test yourself!

Glass Making

A. What occurs when you prepare a "charge" for the electric furnace by under-weighing or over-weighing the following materials on a scale?

1. White sand
2. Calcium oxide
3. Anhydrous sodium carbonate

B. What process would you use to produce a glass jar?

C. Why is it important to put on dark glasses before activating the furnace?

Glass Fabrication

A. Describe the glass part assembly processes.

B. Why should the foil through be extruded through two dies?

C. How could you cut glass with heat instead of a glass cutter?

TAM #3 - Post--assessment

Instructions:

1. Complete the self-check on the glass making and fabrication project you built.
2. Have the instructor complete the evaluation and discuss discrepancies between the two assessments.
3. Complete the post-test for TAM #3.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #3 - Post-test (Glass Fabrication & Processing)

Course: Introduction to Materials & Processing Technology **Date:**________

Tam# 3 **Title:** Glass Fabrication & Processing

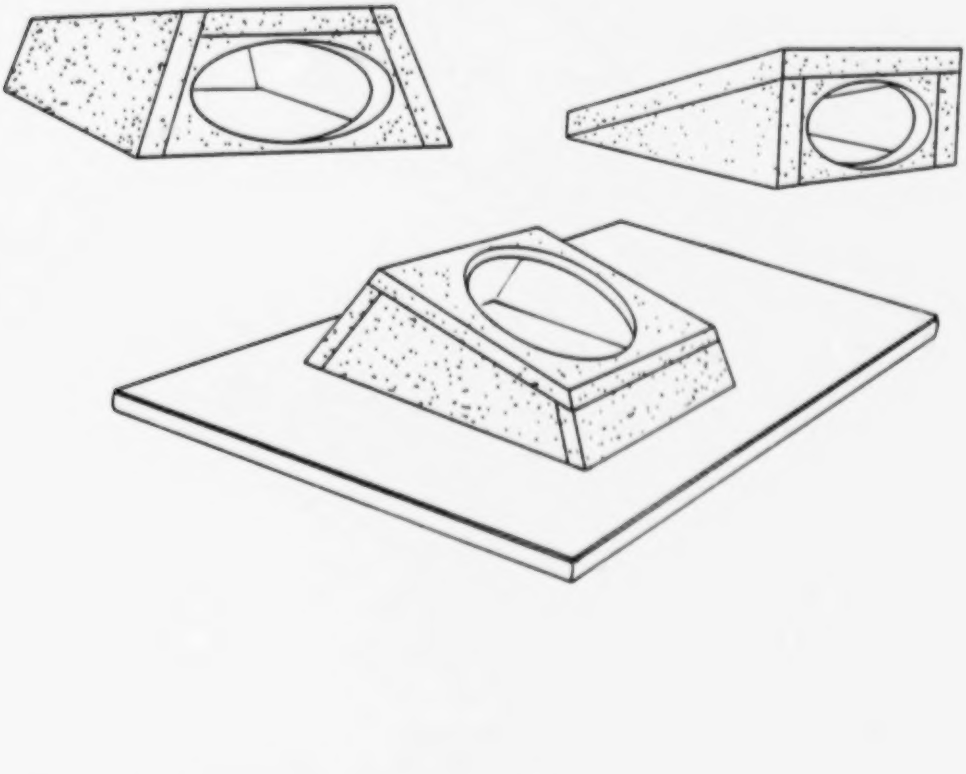
Student Name:________________________

	TASK	**Performance Rating** **Poor Excellent** **1 2 3 4 5**
	Making Glass:	
1.	Did you prepare a "charge" for the electric furnace correctly?	__:__:__:__:__
2.	Did you measure 1-2 oz. white sand correctly?	__:__:__:__:__
3.	Did you measure 0.4 oz. calcium oxide correctly?	__:__:__:__:__
4.	Did you measure 0.4 oz. anhydrous sodium carbonate correctly?	__:__:__:__:__
5.	Was the charge mixed thoroughly?	__:__:__:__:__
6.	Was the "charge" put between electrodes?	__:__:__:__:__
7.	Did you wear dark glasses?	__:__:__:__:__
8.	Did you activate the furnace successfully?	__:__:__:__:__
9.	Was your mixing adequate?	__:__:__:__:__
10.	Did you remove the glass with porcelain probe successfully and press it into shape?	__:__:__:__:__
	Fabrication of Glass	
1.	Did you develop a design product successfully?	__:__:__:__:__
2.	Was the construction of a paper pattern of the design done using the exact dimensions?	__:__:__:__:__
3.	Was the transfer of the pattern dimensions to glass done with a grease pencil?	__:__:__:__:__
4.	Did you cut the glass to size with a glass cutter successfully?	__:__:__:__:__
5.	Did you sand all cut edges with aluminum oxide sandpaper correctly?	__:__:__:__:__
6.	Was the copper foil cut into 3/8" wide stripes with scissors successfully?	__:__:__:__:__
7.	Did you lubricate copper foil and dies?	__:__:__:__:__
8.	Did you extrude the foil through die #1 and then die#2 successfully?	__:__:__:__:__
9.	Was the perimeter of each glass measured accurately?	__:__:__:__:__
10.	Was the rimming of each glass completed successfully?	__:__:__:__:__
11.	Was the paste flux brushed onto joints successfully?	__:__:__:__:__
12.	Did you tack glass pieces together at enough points to secure the assembly?	__:__:__:__:__
13.	Was the finished leaded joint attractive?	__:__:__:__:__
14.	Did you polish all joints with steel wool successfully?	__:__:__:__:__
		Total:__

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #4

Fiberglass Fabrication



TAM #4: Fiberglass Fabrication

Instructor Component

Activity Objective: **This activity will guide students through a series of processes that can be performed in the manufacture of fiberglass products. The processes include: project design, material selection, fabrication molding, lay-up/lamination. As such, they introduce an important way of working with thermo-setting plastics**

Activity Competencies: After finishing this TAM, the student will be able to:

1. Secure and evaluate feedback to assess the effectiveness of materials processing methods. [3,VI]
2. Produce a variety of appropriate fiberglass products using appropriate methods. [3,VI]
3. List important quality characteristics necessary for the informed purchase and use of selected materials in fiberglass. [3,VII]
4. Identify factors which make materials affordable or expensive. [3,VIII]
5. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII]
6. Identify and describe the equipment and materials used in materials testing. [3,IX,A]
7. Trace the path of synthetic materials from their extraction/harvesting, through their processing into industrial standard stock, to the finished product. [3,V]

Module Instructions

Introduction:

This activity guides students through the design, mold building and lay-up processes used with fiberglass reinforced plastics. It is suggested that the activity be incorporated as part of a larger unit dealing with the nature and processing of synthetic materials. The TAM's activities include: demonstrations and procedures, safety instructions, pre-test and post-test as well as the actual fabrication of a product.

Safety Precautions:

Fiberglass reinforced plastic materials are generally safely handled by the average person. This is particularly if routine precautions are taken. Safety is very important in the laboratory, and it is no less important when using fiberglass. Some of the main things to consider when working with fiberglass and resins in the laboratory are: Room ventilation, handling of curing agents, protecting the eyes and skin, and protecting against the ingestion of glass and resin particles when sanding.

Needed Materials:

1. Supplies

- Solder
- Bolts
- Screws & nuts
- Polyester resin with catalyst
- Mixing bucket & cups
- Sticks for mixing
- Glue, polyvinyl or rubber
- 1/4" plywood
- Fiberglass cloth
- Glass roving
- Solvent
- Paste wax
- Wire
- Polystyrene foam planks
- Corrugated cardboard
- Duct/drafting tape

2. Equipment

- Bristle brushes (disposables0
- Resin spreader
- Portable electric drill & bits
- Gloves
- Goggles
- Aprons
- Pressure bag molding apparatus (self built)
- Vacuum cleaner

3. Handouts

A. Student component of TAM #4.

B. Fibrous glass reinforcement handouts.

C. Properties of plastics handout.

4. Instructional Resources

A. Film (select a current title from the media sources in this guide's section III, part 4).

B. Books and Articles

Baird, R. J. (1986). Industrial plastics. South Holland, IL: Goodheart-Willcox. pp. 195-218.

Cope, D. & Schaude, L. (1982). Plastics. South Holland, IL: Goodheart-Willcox. p.87.

Lauton, E. (1964). Industrial arts plastics. Peoria, IL: Chas. A. Bennet. pp. 134-150.

Steele, G. E. (1962). Fiberglass projects and procedures. Bloomington, IL: McKnight & McKnight. pp. 11-92.

Swanson, R. S. (1965). Plastics technology,basic materials and processes. Bloomington, IL: McKnight & McKnight . pp. 191-198.

C. A guest lecturer

D. Field study -- The group/class should be able to visit the following places/or at least one of the following places.

1. Boat building companies.
2. Bass Proshop
3. Bryco - Prothetic Company
4. AB Chance - Fiberglass/High power application
5. Car body shops
6. Camper Shell Company
7. Airplane factory - McDonell Douglas

Management/Logistics:

1. Related TAMS

No other TAMS relate directly to fiberglass reinforced plastics (FRP). However, the problem solving and production TAMS could be made to apply easily.

2. Evaluation/Grading

A. Evaluate the FRP product's design/sketch based on the design principles of form, function and ease of manufacturing.

B. Consider pre-test and post-test results in addition to the rating of the students' final projects taken by students.

3. **Suggested Schedule/Time**

Two weeks is a reasonable time for completion of design and fabrication of the FRP product. An additional week may be useful to permit better finishing.

4. **Instructional Management**

The design and production of FRP speaker enclosures or other such small products is far more feasible than larger projects such as canoes or car-top carriers. The latter should only be considered when undertaking a long-term class project. Other alternative projects could include clipboards, boomerangs, skateboards, hood scoops etc.

Key Instructional Suggestions:

1. **Safety**

Have students read all safety rules supplied with the plastic resins, catalysts, pigments and solvents. Additionally refer them to, and subsequently test them about, safety knowledge such as that listed in a good text e.g., Baird's Industrial Plastics.

Because of the toxic fumes of many resins and solvents be sure to have superior ventilation and respirators with an appropriate filter cartridge! Goggles must be of the splash-proof kind and disposable aprons and gloves protect the skin and clothing well. Guard against fires by not having any open flames in the same laboratory when FRP solvents are present.

Become familiar with the emergency procedures for inhalation, ingestion and excessive contact of the resins and solvents you have students use.

2. **Motivation**

The beauty of this TAM is that it is so adaptable to student interests. Speaker housings, hood scoops, containers, and skateboards are but some of the possible projects. If you allow student interests to lead, they will surely come up with small-scale interesting projects.

3. **Prerequisite Information**

Basically none other than the use of basic hand tools. The instructor would be well advised to first explain and/or demonstrate the overall nature of FRPs and the lay-up process using an illustrated lecture.

4. Demonstrations

The essential demonstrations include:

- Mixing resin, pigment and catalyst
- Building a foam mold
- The lay-up process
- The clean-up procedure

5. Reinforcement

The nature of this TAM lends itself well to integration with the students' work in chemistry and science classes. The ITE instructor could easily reinforce chemical concepts such as: Exothermic reactions, chemical reactions, molecular structure, the nature of catalysts, and the like.
In the mathematics area, the key concepts to reinforce are proportions and ratios.

6. Attitudes:

The key attitudes important to this TAM are extreme care about safety with chemicals. This could possibly be tied in to substance abuse also, particularly inhalation.

7. Remediation/Enrichment:

A. Remediation: Students finding this TAM difficult should be paired with other more proficient classmates. Also the instructor needs to keep these students' projects simple.

B. Enrichment: Point out the increasing use of composite materials and newer fibers such as carbon and Kevlar. Have advanced students prepare a research project on these new materials and if possible make a display of some samples. Also, assign some of the advanced students to build a pressure bag molding apparatus.

8. Summary & Review

- Mold making
- Thermosetting and thermoplastic materials
- Chemical reactions
- Catalytic actions
- The lay-up process
- Finishing FRP products

9. **Review Questions & Answers** *(Answers are in italics)*

A. Resins most commonly used for hand lay-ups with glass fiber materials are:

1. polyesters
2. epoxies

B. *Glass fibers* are the leading materials in reinforcements for molding.

C. The two types of spray lay-up systems involved are:

1. cavity or positive shape
2. multi-head spray gun

D. Foamed plastics are made by adding *1. air or gas* to a plastic resin to form a *2. sponge-like* material.

E. Plastic foams have either an *1. open* or a *2. closed* cell structure.

F. Plastic foam are classified into four major areas of use:

1. flotation
2. packaging
3. customizing
4. insulation

G. The principle of bonding two plastic materials together may be classified as *1. cohesion* or *2. adhesion.*

Date: __________ Class: ___________ Name: ________________

TAM #4 - Pre-test (Plastics Fabrication)

Instructions: Have students try to answer this test when beginning the TAM. Then discuss the answers they were able to find and assign the getting of the remainder as homework.

1. The safety procedure(s) important to working with polyester resin is(are): [M & P, T#4 3, VIII]

   a. Adequate ventilation
   b. Use of disposable gloves
   c. Use of aprons
   d. Protecting the work bench surface
   e. All of the above

2. Fiberglass is classified as: [M & P, T#4 3, V]

   a. A ceramic material
   b. An organic
   c. A synthetic
   d. A metal
   e. None of these

3. The temperature appropriate to most fiberglass lay-up is: [M & P, T#4 3, VIII]

   a. 72° to 74° F
   b. 82° to 84° F
   c. 92° to 94° F
   d. Above 94° F

4. Fiberglass reinforced products are comprised of: [M & P, T#4 3, V]

   a. Plastic resins
   b. Glass fibers
   c. Glass fibers and plastic resins
   d. Fiberglass mat & fiberglass cloth
   e. Fiberglass mat & fiberglass roving

5. The fiberglass lamination process used most generally for home and school work is: [M & P, T#4 3, VIII]

   a. Vacuum bag molding
   b. Pressure bag molding
   c. Matched-Die molding
   d. Contact molding

Instructions: The following questions are either true or false. Please circle the correct answer.

6. Superior fiberglass laminates can be produced by careful use of materials and attention to special precautions. T F
7. Lay-up coats should be placed on the mold one at a time. They should be well saturated with the resin before nest layer is applied. T F
8. Decorative materials should bot be applied between the glass materials layers. T F
9. Glass cloth can be applied without much air being trapped under the cloth, but glass mat will trap air more easily. T F

(Steele, 1962)

TAM #4 - Post-test – Rating Form (Plastic Fabrication)

Course: Introduction to Materials & Processing Technology **Date:** ________

TAM# 4 **Title:** Fiberglass Fabrication

Student Name: ______________________________

TASK	Performance Rating Poor Excellent 1 2 3 4 5
1. Appropriate product design specifications were developed	__:__:__:__:__
2. A quality foam mold was prepared	__:__:__:__:__
3. Fiberglass reinforcing materials were precut and trial fitted	__:__:__:__:__
4. The resin was properly prepared and mixed	__:__:__:__:__
5. The lay-up process was followed as demonstrated	__:__:__:__:__
6. All the fiberglass reinforcing was properly oriented and saturated with resin	__:__:__:__:__
7. The proper thickness was built up	__:__:__:__:__
8. The product was finished appropriately	__:__:__:__:__
9. All tools and work areas were properly cleaned	__:__:__:__:__
10. Proper safety precautions were followed	__:__:__:__:__
	Total: ___

TAM #4 - Test Keys (Plastic Fabrication)

TAM #4 - Pre-test

1. e 2. c 3. b 4. c 5. d

6. T 7. T 8. T 9. F

TAM #4 - Post-test

A rating form is used as a post-test.

TAM #4: Fiberglass Fabrication

Student Component

Introduction:

Fiberglass fabrication opens up a whole new way of making projects. You are encouraged to try to find interesting activities which result in a useful product and that also use as many processes as the equipment and facilities allow. However, for your first projects, keep them small because of the materials' cost.

Activity Competencies: After finishing this TAM, you will be able to:

1. Secure and evaluate feedback to assess the effectiveness of materials processing methods. [3,VI]
2. Produce a variety of appropriate fiberglass products using appropriate methods. [3,VI]
3. List important quality characteristics necessary for the informed purchase and use of selected materials in fiberglass. [3,VII]
4. Identify factors which make materials affordable or expensive. [3,VIII]
5. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII]
6. Identify and describe the equipment and materials used in materials testing. [3,IX,A]
7. Trace the path of synthetic materials from their extraction/harvesting, through their processing into industrial standard stock, to the finished product. [3,V]

Module Overview:

This TAM contains two activities:

1. Making a foam mold.
2. Laminating a fiberglass reinforced product (such as a speaker housing).

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and by reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 -- Making the foam mold.
4. Do Activity #2 -- Laminating the fiberglass product.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. **Class Presentations**

   - Plastic safety
   - Catalysts & Resins
   - Reinforcements
   - Steps of procedure

2. **Demonstrations**

   - Designing the model
   - Mixing plastic resin
   - Hand lay-up of FRP
   - Assembling the finished speaker

3. **Safety**

   A. Use chemical/splash resistant safety glasses or face shield.

   B. Work only in well ventilated area.

   C. Do not touch your skin when coming in contact with chemicals.

   D. Do not bring resins and catalysts near fire or sparks.

   E. Make sure to wear an apron and use disposable gloves.

   F. Mix chemicals in a disposable container.

   G. Cover the work bench with a polyethylene sheet.

H. Be sure to protect all parts of the body when sanding

I. Use chemical respirator while laminating and/or sanding.

J. Get clearance from the instructor before you use any chemical or material and doublecheck all measurements.

L. Keep resins and catalysts away from the sun, heat or flame.

M. Do not mix accelerators and catalysts together directly. Add each of them separately to the resin. Mix thoroughly.

(Lauton, 1964)

4. Personal Activity

As homework, identify and read some professional magazines and trade journals that contain information related to this TAM. Also the listed sections in the following books are useful:

Cope, D. W and Schaude, L. E. (1982). Plastics. South Holland, IL: Goodheart -Willcox. pp. 87-87.

Swanson, R. S. (1965). Plastics technology,basic materials and processes. McKnight & McKnight. pp. 191-198.

Glossary:

Catalyst	A substance that starts a chemical reaction but that is not a part of that reaction.
Exothermic Reaction	A chemical reaction that gives off heat.
Fabrication	The making of things.
Fiberglass Reinforced Plastic	A product that consists of plastic resins surrounding and saturated through glass fibers usually in the form of cloth or mat.
Glass Mat	A loosely packed together sheet of glass fibers. It is distinguished from cloth in that mat fibers are not woven together.
Lay-up	The process of saturating glass cloth or mat with plastic resin.
Plastic Foam	A block or sheet of plastic resin that has many air pockets throughout it, like a sponge. Plastic foam may be rigid (open-celled or beaded) or flexible.
Plastic	An organic or synthetic material that is capable of heat or chemical fabrication and that is not a metal, ceramic or natural material.
Resins	An organic or synthetic chemical, usually in a liquid form, that becomes hard when exposed to heat or catalysts or both.
Silicone	A material that forms a very slippery coating which keeps other materials from adhering to any surface coated with it.
Woven Roving	A coarse fiberglass cloth made of large strands of twisted glass fibers. It is typically used to build up bulk or thickness. It does not yield as smooth a surface as glass cloth but it is usually much less expensive.

Needed Materials:

1. Supplies

- Solder
- Bolts
- Screws & nuts
- Polyester resin with catalyst
- Mixing bucket & cups
- Sticks for mixing
- Glue, polyvinyl or rubber
- 1/4" plywood
- Fiberglass cloth
- Glass roving
- Solvent
- Paste wax
- Wire
- Polystyrene foam planks
- Corrugated cardboard
- Duct/drafting tape

2. Equipment

- Bristle brushes (disposables)
- Resin spreader
- Portable electric drill & bits
- Gloves
- Goggles
- Aprons
- Pressure bag molding apparatus (self built)
- Vacuum cleaner

3. Handouts

A. Student component of TAM #4.

B. Fibrous glass reinforcement handouts.

C. Properties of plastics handout.

TAM #4 - Fibrous Glass Reinforcements Handout

Type	General Description	Directionality	% Glass Content	General Use	Relative Cost	Relative Usage
Reinforcing mats	Non-woven matting	Non-Directional	20-45	Simple contours	Medium	Great
Rovings	Rope-like bundles of continuous strands	Unidirectional	50-70	Preforming Unidirectional	Low	Great
Chopped strands	Bulk, cut strands	Non-directionals	15-45	Compression molding	Low	Medium
Milled fibers	Small filaments	Non-directional	2-10	Castings	Low	Very Small
Surfacing mat	Non-reinforcing	Non-directional	5-15	Surface	High	Small
Beams	Parallel yarn	Unidirectional	50-80	Cylinders	Medium	Very Sm
Fabrics	Many styles, with finish	Unidirectional or bidirectional	45-65	High performance parts	High	Great
Woven rovings	Coarse, heavy fabrics	Bidirectional	45-65	Boats	Medium	Medium

[Adopted from Swanson, 1965, p.147]

TAM #4 - Properties of Plastics Handout

The general properties of different materials are understood by the layperson. That is, people generally know that wood burns, and that most metal do not, that iron rusts and glass does not, that rubber is elastic and paper tears when stretched, The properties of plastics are as commonly known and appreciated.

However, the term "plastics" is cued to refer to many groups of materials. Many members of the group have widely different proprieties just as many members of the wood or metal families have different properties. However there are generally properties that are quite characteristic of the plastic's family. These are divided into physical and chemical properties.

Physical Properties

Weight:	Most plastics are relatively light in weight.
Hardness:	Plastics are not very hard. The hardest types compare with brass and aluminum.
Tensile Strength:	In this property, there is great variety among plastics. Polyesters reinforced with fiber glass achieve a tensile strength up to 100,000 lbs (psi)
Compressive Strength:	There is a great variety among plastics in this property. e.g. polyesters, reinforced with glass rovings resist forces of 70,000 psi as compared to 12,000 psi for aluminum.
Impact Strength:	This is a measure of the toughness of the plastic. Some fiber glass reinforced plastics. e.g. epoxies and polyester possess higher impact strengths than steel.
Fatigue:	It is the ability of plastic to recover form applied load. Vibration taxes this property of the material.
Damping:	Plastics are particularly vibration absorbent, about ten times more than steel. As such plastic gears are much less noisy than metal ones.
Viscosity:	Many Plastic resins are supplied in liquid form range in stiffness, from very free-flowing to thick, sticky masses.

Chemical Properties

Resistance to Acids:	Most plastics are extremely resistant to weak acids. Many are resistant to strong mineral acids.
Resistance to Alkalies:	Most plastics are very resistant to weak alkalies, but only about half of them resist strong alkalies completely.
Resistant to Other Chemicals:	Most plastics are resistant to common vegetable and mineral oils and greases, etc. Almost all plastics are impervious to the effects of moisture and actual immersion in water. As such, it is important to select a plastic materials carefully if it must withstand volatile solvents, fumes, strong chemicals.,etc.

Polyester Resins Characteristics

Polyester is best known as the resin combined with glass mat or shopped fibers and are called fiber glass. The properties of polyesters are varied as to the form in which they are processed. In general they have very good weathering and chemical resistance properties, withstanding most solvents, acids, and salts. Polyesters are quite strong and tough, and depending upon the materials used for reinforcing, can be made rigid or fairly flexible. The electrical insulation properties are high along with good heat resistance to 500 °F. and colorability. Polyesters are available as liquid resins along with catalyst which are mixed at the time of use. Premixed molding compounds with filler are available for immediate use. These compounds will react if not used quickly or kept cold.

Epoxy Resin Characteristics

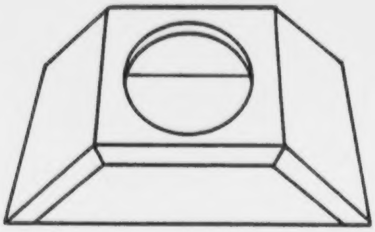
Epoxy resins are formulated in such a manner that they are adaptable to many processing techniques. In each of these, the outstanding characteristics of the epoxies provide excellent chemical resistance, electrical properties, and toughness. Most epoxy products can be used continuously at temperatures up to 300 °F. while special formulations with fillers and additives retain their properties at continuously elevated temperatures up to 500 °F. They have excellent mechanical and thermal shock resistance except for some rigid formulations which are quite brittle. Weather resistance and low temperature properties are good, even to temperatures at -70°F.

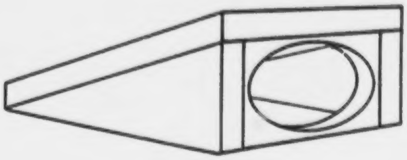
(Adapted from Baird, 1971, pp. 29-62)

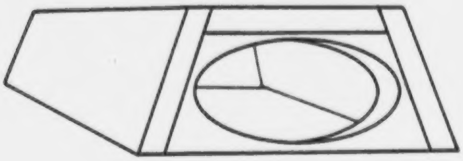
Activity #1 - Making a Foam Pattern for a Fiberglass Speaker Housing: Plan of Procedure

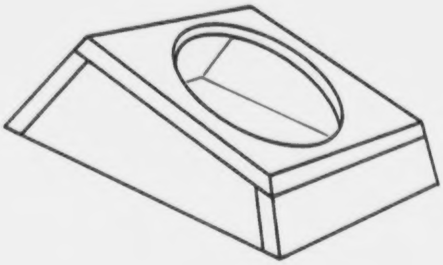
1. The instructor will demonstrate how to make a foam pattern for a fiberglass speaker housing or similar product.

2. Design your project using dimensions secured from the car or boat in which the speakers are to be mounted.



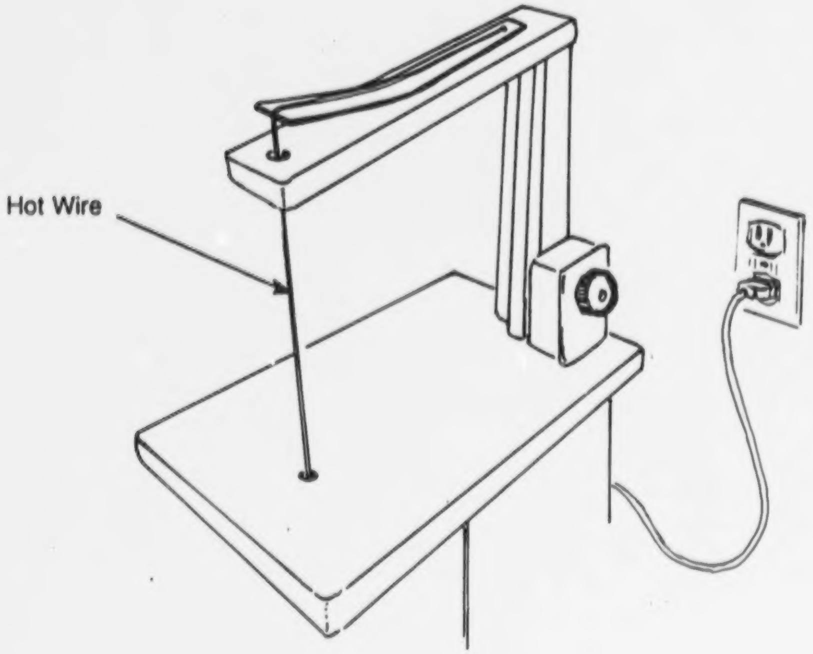






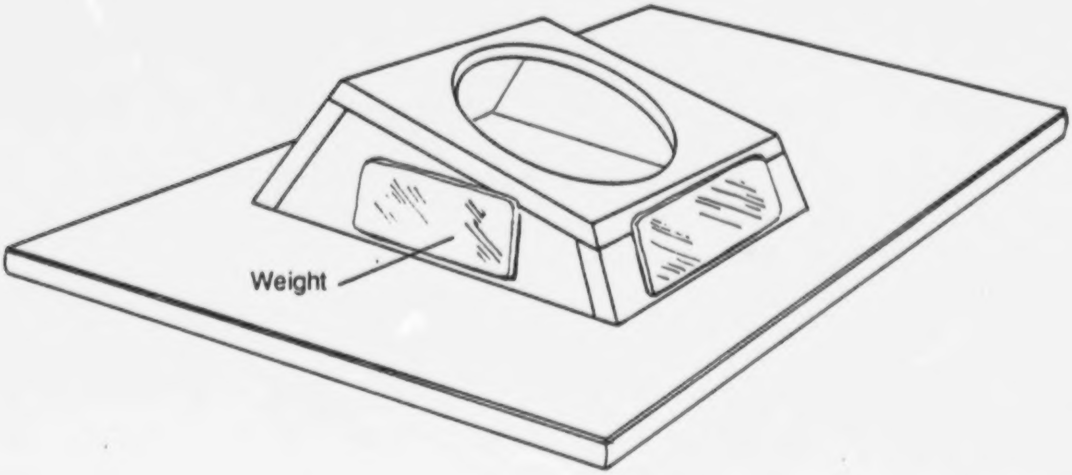
3. Using corrugated cardboard and masking or duct tape, make a cardboard mock-up of the speaker housing and check that it fits the car or boat properly. Doublecheck that the speaker fits into the housing mock-up. Then layout the proper shapes and dimensions to create a mold from polystyrene foam plastic.

4. Cut the foam to shape, using any or all of the following: a hot wire cutter, knife, jig saw or band saw.

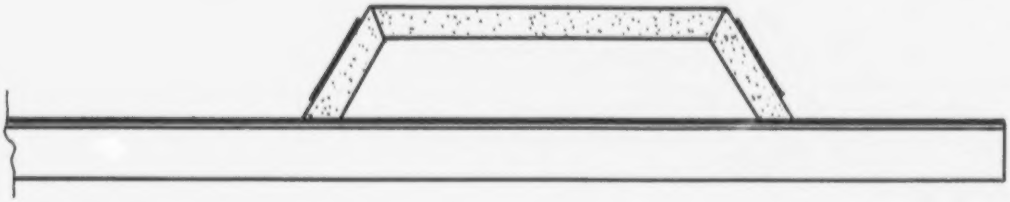


5. Assemble foam sections into the desired shape. Use polyvinyl wood glue or rubber cement to hold the pieces together.
6. Shape the corners and other desired contours using a hot wire cutter, knife or rasp.
7. Trial fit the finished foam mold to the space for it to be sure that you have not made any mistake.

8. If you have large flat surfaces, cut steel weights to fit them. These will be used to strengthen the final project and to eliminate excessive sound resonance. Sand each weight lightly and then, using rubber cement, glue them into position on the foam pattern. If you wish you can use a razor knife to sink them flush with the foam's surface.



9. Place the foam mold into a plastic laminate covered board and hold it in position with rubber cement.



Activity #2 - Laying-up and Finishing a Fiberglass Speaker Housing: Plan of Procedure

1. The instructor will demonstrate how to lay-up a fiberglass speaker housing or similar product.

2. Follow proper safety precautions:

    a. Be sure there is adequate ventilation in the laboratory.

    b. Wear aprons, disposable gloves, splash proof eye goggles and a chemical cartridge respirator.

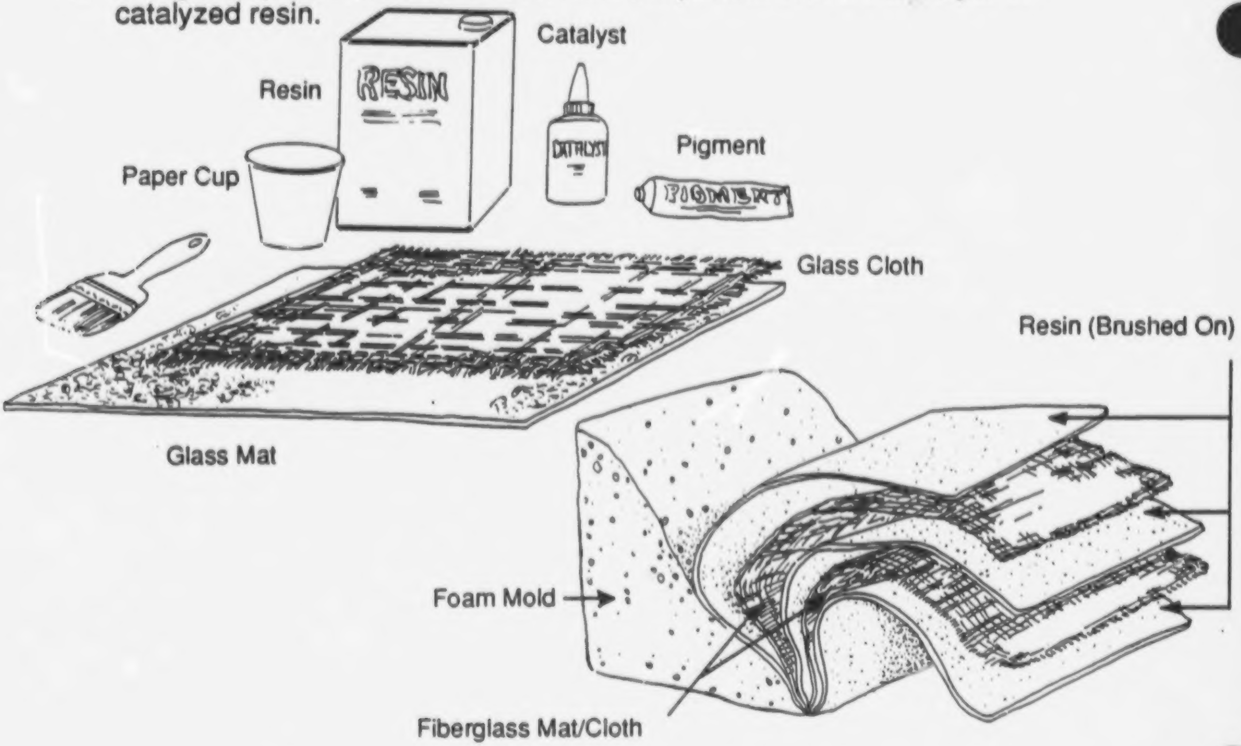
    c. Cover the workbench with a polyethylene sheet and tape it down.

    d. Do not touch your skin while working with fiberglass.

3. Cut several layers (3 minimum) of fiberglass mat or cloth large enough to completely drape over the mold and leave about a 2" wide lip.

4. Mix an appropriate amounts of resin, catalyst (MEK -- extra care must be taken when using this since, it is very dangerous), pigment, accelerator and other additives as appropriate.

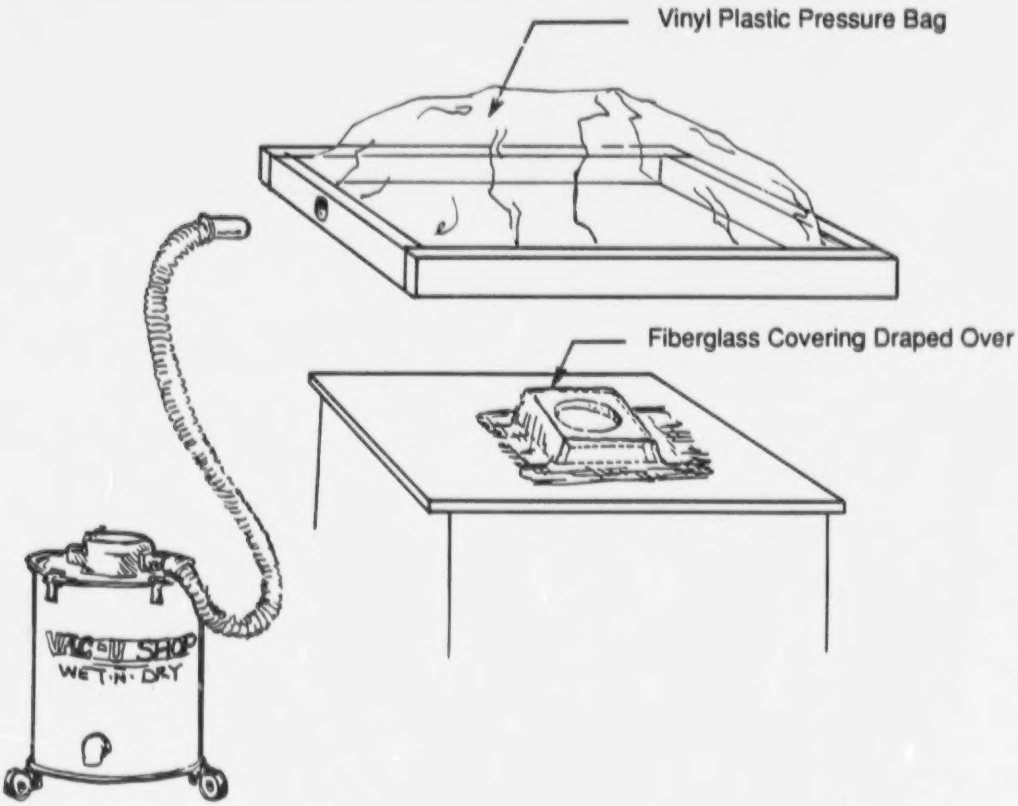
5. Using a disposable brush or roller coat the pattern with a thick layer of catalyzed resin.


Catalyst
Resin
RESIN
CATALYST
Pigment
PIGMENT
Paper Cup
Glass Cloth
Resin (Brushed On)
Glass Mat
Foam Mold
Fiberglass Mat/Cloth

6. After this layer has just started to set, press the first layer of fiberglass cloth or mat into it. Then saturate this reinforcing material with more resin until there are no air pockets. Repeat with a layer of resin and a layer of mat until all is used up. Then:

   a. Press cloth with resin tightly into corners to eliminate any air pockets.

   b. Alternatively use a home-built pressure bag molding apparatus, as shown in drawing to press cloth with resin tightly into corners to eliminate any air pockets. Note that a wet/dry vacuum cleaner should be used but a surplus vacuum pump is even better.



7. After the project has hardened, lay out the center point of the face (where the speaker will mount) and drill a through holes about 1/2" in diameter.

8. Using a coping saw, cut out the speaker opening so that the speaker can be mounted into the fiberglass shell that you have just made.

9. Drill the speaker mounting holes using a speaker as a layout pattern and drill a small hole at the back of the speaker housing for the speaker wire

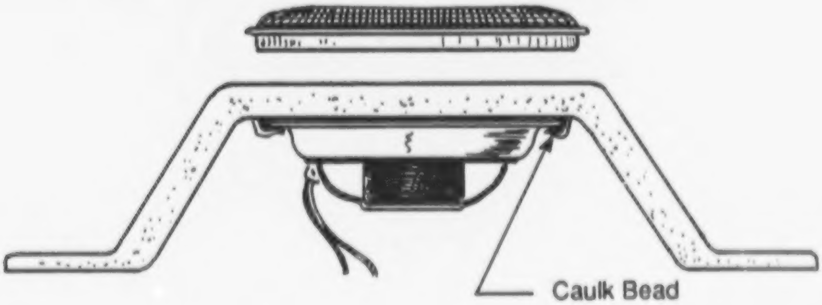
10. Build/buy a speaker grille using wood, plastic or commercially available grille cloth/foam.

11. Mount the speaker to the fiberglass enclosure using nuts and bolts. Depending on how you made the foam pattern, you may have to cut out the foam from the fiberglass shell first.

12. Run a bead of silicone caulk around the speaker--housing contact point.

13. Solder or crimp connect the wires from the radio or terminals to the speakers after testing to be sure everything works properly.

14. Test the speaker.



TAM #4 - Summary

1. **Review & Summary Activities**

   This TAM introduces you to the basic processes of fiberglass works. It enables you to compare the methods in terms of temperature requirements, forces required and means by which one can shape fiberglass.

   Fiberglass has become a part of our community. Its roles in shaping and modernizing your society cannot be over emphasized. Using the basic concepts you learned in this TAM, you can apply fiberglass for your own personal projects such as canoes, homes, cars, etc.

   There is no doubt, this is the age of fiberglass. In the near future, it will make things possible which you might think were never possible. Most will have never been done before!

2. **Review Questions -- Test yourself!**

   Instructions: The following questions are true or false. Please circle the correct answer.

   A. T/F Superior fiberglass laminates can be produced by careful use of materials and attention to special precautions.

   B. T/F Lay-up coats should be placed on the mold one at a time. They should be well saturated with the resin before next layer is applied.

   C. T/F Decorative materials should not be applied between the glass material layers.

   D. T/F Glass cloth can be applied without much air being trapped under the cloth, but glass mat will trap air more easily. (Steele, 1962)

TAM #4 - Post-assessment

Instructions:

1. Complete the self check on the speaker housing and process.
2. Have the instructor complete the evaluation and discuss discrepancies between the two assessments
3. If your results demonstrate mastery, go on to the next TAM or activity as assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #4 - Post-test -- Rating Form (Plastic Fabrication)

Course: Introduction to Materials & Processing Technology **Date:** ________

TAM# 4 **Title:** Fiberglass Fabrication

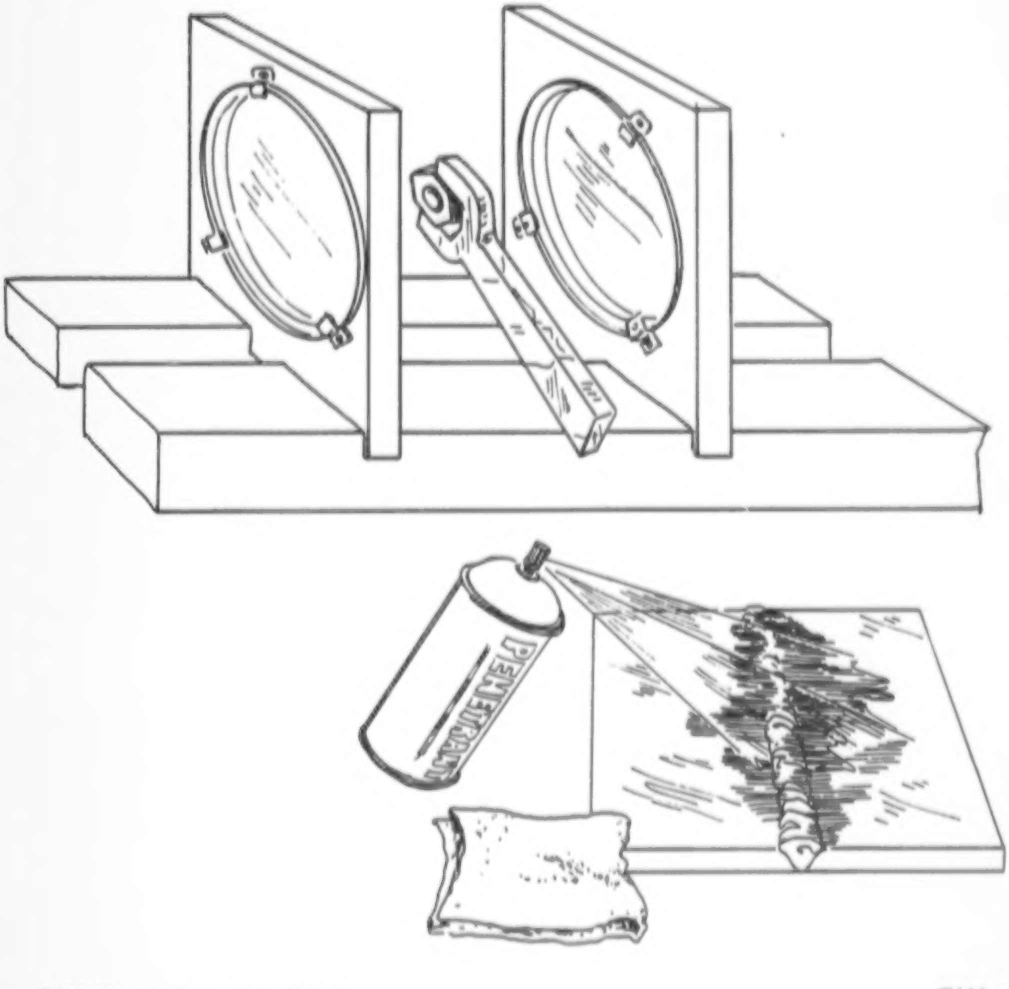
Student Name: ________________________________

TASK	Performance Rating Poor Excellent 1 2 3 4 5
1. Appropriate product design specifications were developed	_:_:_:_:_
2. A quality foam mold was prepared	_:_:_:_:_
3. Fiberglass reinforcing materials were precut and trial fitted	_:_:_:_:_
4. The resin was properly prepared and mixed	_:_:_:_:_
5. The lay-up process was followed as demonstrated	_:_:_:_:_
6. All the fiberglass reinforcing was properly oriented and saturated with resin	_:_:_:_:_
7. The proper thickness was built up	_:_:_:_:_
8. The product was finished appropriately	_:_:_:_:_
9. All tools and work areas were properly cleaned	_:_:_:_:_
10. Proper safety precautions were followed	_:_:_:_:_
	Total: ___

Course:	Introduction to Materials and Processing Technology

Technology Activity Module #5

Nondestructive Testing:
Dye Penetrant & Polarized Light Testing



TAM #5: Nondestructive Testing

Instructor Component

Activity Objective: The objective for this activity is to explain to the student what nondestructive testing (NDT) is and to do this by using the examples of penetrant and polarized light testing. This TAM shows how liquid penetrant testing is performed to nondestructively insure the reliability of today's machines, equipment and tools. Polarized light testing will be shown as an analytical tool useful to the design process.

Activity Competencies: By completing this TAM, the student will be able to:

1. Describe and give examples of the categories of materials,properties and characteristics. [3,I]
2. Provide some key examples of the relationship between the structure of materials and their properties. [3,III]
3. Discuss the advantages and disadvantages of destructive and nondestructive testing. [3,IV]
4. Employ nondestructive methods to identify major characteristics and properties of materials. [3,IV,A]
5. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII,C]

Module Instructions

Introduction:

The activities in this module are designed to teach about nondestructive testing in general and about dye penetrant and polarized light testing in particular. Students will actually dye penetrant test a sample and they will design a component aided by the polarized light test. It is suggested that the instructor contrast this activity to destructive testing. The activities in this module include: pre-test, post test, demonstrations, safety and a summary/discussion in addition to the actual dye penetrant testing of a sample part and the polarized light testing of sample designs.

Safety Considerations:

Dye penetrant testing requires the safe application of the liquid penetrants, often by spraying, and other chemicals. Careful attention should be given to appropriate safety precautions, e.g., eye protection (splash proof), gloves, respirators (depending on the chemicals), ventilation and soiled rag storage. Because dye penetrant kits use different chemicals, be sure to read the kit's specific instructions.

Needed Materials:

1. **Supplies**

   Dye Penetrant Testing
   - Metal or ceramic samples to be tested, e.g., weldments or castings
   - Metal check/flaw - Finder kit that includes:
     - -Cleaner
     - -Penetrant
     - -Developer
     - -Remover
   - Tissue paper, rags

   Polarized Light Testing Supplies
   - Cast acrylic plastic strips or stock

2. **Equipment**

   Welding (to produce sample if necessary)
   - Tungsten inert gas welding outfit
   - Metal.inert gas welding outfit
   - Conventional arc welding outfit -- welding hood
   - Welding goggles and safety equipment
   - Splash proof goggles
   - Gloves

   Dye Penetrant Testing Equipment
   - Splash-proof goggles
   - Gloves
   - Ultra-violet light

   Polarized Light Testing Equipment
   - Polariscope (light source, two polarizing filters, easily self-built)

3. **Handouts**

   A. Student component of TAM #5

4. Instructional Resources

A. Films (contact associations such as the American Society for Testing and Materials and/or suppliers like the Magna-Flux Corporation for available films and videos).

B. Transparencies. Most welding supply houses sell penetrant test kits and have literature that can be converted into effective transparencies.

C. Books and Articles

American Society of Mechanical Engineers. (1983). Boiler and pressure vessel code. Section VIII. New York: ASME.

American Society of Nondestructive Testing. (1980). Recommended practice. SNT-TC-1A.

Betz, C. E. (1969). Principles of penetrants. Chicago, IL: Magnaflux. Catalog Card #76-95933. pp. 1-20.

D. Catalogs. The Magna-Flux Corporation has available many very informative catalogs and/or brochures about a variety of nondestructive testing methods.

E. Field trips: Schedule a visit to a local automotive/farm equipment/aircraft overhauler or machine shop. Power plants also employ NDT.

Management/Logistics:

1. Related TAMS

No other TAMS are directly related to nondestructive testing. Effectively this nondestructive testing TAM could be used to lead into the bridge building TAM. The problem-solving TAM, also, could be linked to it by the instructor For example, the problem would be how to identify flaws in a material without ruining it. Similarly, if the class is doing a mass production activity then sample products could be tested using nondestructive approaches.

2. Evaluation/Grading

Two methods are suggested: The first is based on written test performance and the second is based on observing the students' ingenuity in using dye penetrant and polarized light testing.

3. Suggested Schedule/Time

The time suggested for this TAM is one to two weeks.

4. **Instructional Management**

This TAM does not require significant management effort other than having the materials handy. It might be useful to schedule this TAM after students have begun welding. This would provide a ready source of test specimens.

Key Instructional Suggestions:

1. **Safety**

Make students aware of the following safety precautions when performing a liquid penetrant test:

1. Follow precautions printed on labels.
2. Perform dye penetrant test in well-ventilated areas.
3. Avoid prolonged and repeated contact of chemicals with skin.
4. Wear splash-proof goggles to prevent chemicals from entering eyes.
5. Avoid open flames near the test.

2. **Motivation**

The instructor should secure laboratory and instructional aids which can be used to motivate students. Students should be encouraged to bring personal items to be penetrant tested during the laboratory periods. Examples which might be brought include:

1. Car parts
2. Motorcycle parts
3. Aluminum baseball bats, etc.

3. **Prerequisite Information**

None -- however it would be helpful for students to have a basic knowledge of welding processes, if they are to create deliberately flawed specimens.

4. **Demonstrations**

The instructor should perform the liquid penetrant test in the laboratory beginning with a dirty part.

The instructor should show students how to conduct a polarized light test .

5. **Reinforcement**

The purposes of NDT should be stressed. Highlight America's concern for quality in order to be competitive. Guest speakers can be brought from different industries, e.g., railroad, automotive, nuclear, aircraft.

Hands-on training provides the best reinforcement and experience.

6. **Attitudes**

The instructor's own enthusiasm should stimulate students' attitudes. Students' interests should be identified and built upon using examples "close to home."

7. **Remediation/Enrichment:**

A. Remediation: Pair slower students with faster ones if a problem occurs.

B. Enrichment: Get students using the polarized light test to design useful, marketable products. Have advanced students develop a research paper that explains how and why the different colors are created in the specimens.

8. **Summary & Review**

The instructor should summarize and review the following:

A. What is liquid penetrant testing?
B. How is the test performed?
C. What materials can be tested?
D. What safety precautions should be observed in penetrant testing?
E. How is polarized light used to test materials?

9. **Review Questions & Answers** *(Answers are in italics)*

A. Why is it crucial to thoroughly clean a part prior to penetrant-testing it? *To open all cracks and voids sot that the penetrant can seep into them.*

B. What is the purpose of the developer in dye penetrant testing? *To draw out the penetrant from the voids and display its presence by contrast.*

C. How could dye penetrant-testing reveal smaller imperfections? *By using a florescent penetrant that shows up more easily.*

D. What are polarizing filters? *Optical materials that allow only certain angles of light through them.*

E. Why do the colors appear in test specimens in the polariscope? *Because plastic's index of refraction charges with stress.*

Date: _____ **Class:** _______________ **Name:** ________________

TAM #5 - Pre-test (Nondestructive Testing)

Instructions: Circle the correct answer

1. Liquid penetrant testing is: [M&P,T#5,3,1]
   a. nondestructive testing
   b. destructive testing
   c. radiographic testing
   d. none of the above

2. Liquid penetrant testing can be applied to: [M&P,T#5,3,1]
   a. porous materials
   b. ceramic materials
   c. non-porous materials
   d. all of the above

3. Penetrant application means: [M&P,T#5,3,1]
   a. spraying on the specimen
   b. dipping the specimen
   c. brushing the specimen
   d. all of the above
   e. none of the above

4. The liquid penetrant is pulled into the cavity of the defect because of: [M&P,T#5,3,1]

   a. excess liquid
   b. inadequate liquid
   c. capillary action
   d. gravitational pressure

5. Solvent cleaning is a: [M&P,T#5,3,IV,A]
   a. method of penetrant application
   b. method of surface preparation
   c. method of penetrant removal
   d. method of developer removal

6. The function of the developer is to: [M&P,T#5,3,IV,A]
   a. expose the visibility of the surface
   b. highlight the visibility of the developer
   c. increase the visibility of the defect
   d. make the indicator permanent

Question 7 has some blanks that need to be filled. Read the question and the words listed below. From this list, choose the best word to fill each blank.

7. The procedure for performing a liquid penetrant test is relatively simple. The __________ of the specimen is ____________ and the liquid penetrant is __________.

a. Function	b. Surface	c. Excess
d. Cleaned	e. Removed	f. Applied

Date: _____ Class: _______________ Name: _______________

TAM #5 - Post-test (Nondestructive Testing)

Instructions: Answering each question in the space provided. Use complete sentences.:

1. How is the liquid penetrant test conducted?

2. Why are clean surfaces important when using liquid penetrants to test metals for surface and subsurface defects?

3. Explain the difference between developing and inspection in penetrant testing.

4. What happens when a polarized light passes through a clear cast plastic specimen under load?

5. What happens when the two polarizing filters are at right angles to each other?

TAM #5 - Test Keys (Nondestructive Testing)

TAM #5 - Pre-test Answers

1. a 2. b & c 3. d 4. c 5. b 6. c

7. The procedure for performing a liquid penetrant test is relatively simple. The *surface* of the specimen is *cleaned* and the liquid penetrant is *applied*.

TAM #5 - Post-test Answers

Sentence answers required. Therefore, no particular words could be listed as an answer to the questions. The explanations written by each student will need to be judged by the instructor against content of the lessons and demonstrations.

TAM #5: Nondestructive Testing

Student Component

Introduction:

Nondestructive testing is important because it does not destroy the object being tested. After all, you wouldn't want to destructively test a diamond ring, would you? Dye penetrant testing is one of the simplest nondestructive tests that can be applied to a metal. It is an excellent means of testing for porosity and weld inclusions in stainless steel, aluminum and many non-porous metals - and for identifying flaws that might be produced by such manufacturing processes as casting, welding, forging, machining, etc. These tests are relatively inexpensive, simple, easy and quick to perform. This TAM will involve you in these processes. Because of their simplicity, you will be able to do these above tests in your own workshop.

A second form of nondestructive test, using polarized light, will also be part of this TAM. It is recommended for use in the design process of certain projects such as the bridge-building contest.

Competencies: Following the completion of this TAM, you will be able to::

1. Describe and give examples of the categories of materials,properties and characteristics. [3,I]
2. Provide some key examples of the relationship between the structure of materials and their properties. [3,III]
3. Discuss the advantages and disadvantages of destructive and nondestructive testing. [3,IV]
4. Employ nondestructive methods to identify major characteristics and properties of materials. [3,IV,A]
5. Exhibit positive work habits and attitudes as they relate to the safe and skillful use of materials. [3,VIII,C]

Activity Sequence:

This TAM will have you do both dye penetrant and polarized light testing. You will need to follow these steps:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., read the assigned material and review the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 -- Dye penetrant testing.
4. Do Activity # 2 -- Polarized light testing.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. Class Presentations

- Physics principles: Capillary action, light refraction.
- Nondestructive testing contrasts to destructive testing.

2. Demonstrations

- Cleaning the item to be tested.
- Applying penetrant & developer.
- Interpreting results.
- Polarized light testing.

3. Safety

As you work, be sure to follow the safety precautions when performing a liquid penetrant test:

1. Follow precautions printed on labels.
2. Perform dye penetrant test in a well-ventilated area.
3. Avoid prolonged and repeated contact of chemicals with skin.
4. Wear splash-proof goggles to prevent chemicals from entering eyes.
5. Avoid open flames near the test.

4. Personal Activity

Before beginning work on these activities it is recommended that you read:

Kazanas, H.C.; Baker, G. E. & Gregor, T. G. (1981). Basic manufacturing processes. McGraw Hill Book. U.S: ISBN 0-07-033465-X, pp. 88-89.

Kazanas, & Klein & Lindbeck, (1974). Technology of industrial materials. Bloomington, IL: Bennett. pp. 108-109.

Glossary:

Bleedout	Is the action of entrapped penetrant in spreading out from the surface to form an indication.
Capillary Action	The tendency of liquids to penetrate into small cracks, e.g., openings, pits. etc.
Developing	A process that increases the visibility of any penetrant.
Inspection	The process that identifies the presence of a flaw.
Liquid Penetrant	A liquid substance that seeps into any cracks.
Nondestructive Testing	A way of testing an item so that its purpose and/or use is not impaired.
Penetrant Application	The process of applying penetrant to the sample being tested so that it can seep into any cracks or flaws.
Removal	The process of taking away the surface layer of penetrant.
Surface Preparation	The cleaning of the part to be tested.
Weld Inclusion	A void or hole in the weldment, often filled with porous slag.

Needed Materials:

1. **Supplies**

   Dye Penetrant Testing
   - Metal or ceramic samples to be tested, e.g., weldments or castings
   - Metal check/flaw - Finder kit that includes:
     - -Cleaner
     - -Penetrant
     - -Developer
     - -Remover
   - Tissue paper, rags

   Polarized Light Testing Supplies
   - Cast acrylic plastic strips or stock

2. **Equipment**

   Welding (to produced sample if necessary)
   - Tungsten inert gas welding outfit
   - Metal inert gas welding outfit
   - Conventional arc welding outfit -- welding hood
   - Welding goggles and safety equipment
   - Splash proof goggles
   - Gloves

   Dye Penetrant Testing Equipment
   - Splash-proof goggles
   - Gloves
   - Ultra-violet light

   Polarized Light Testing Equipment
   - Polariscope (light source, two polarizing filters, easily home built)

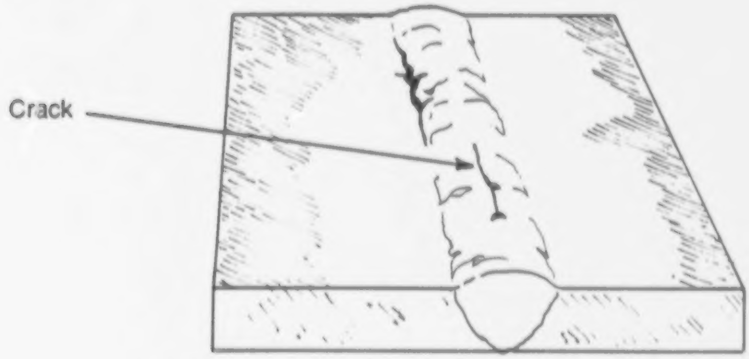
3. **Handouts**

   A. Student component of TAM # 5

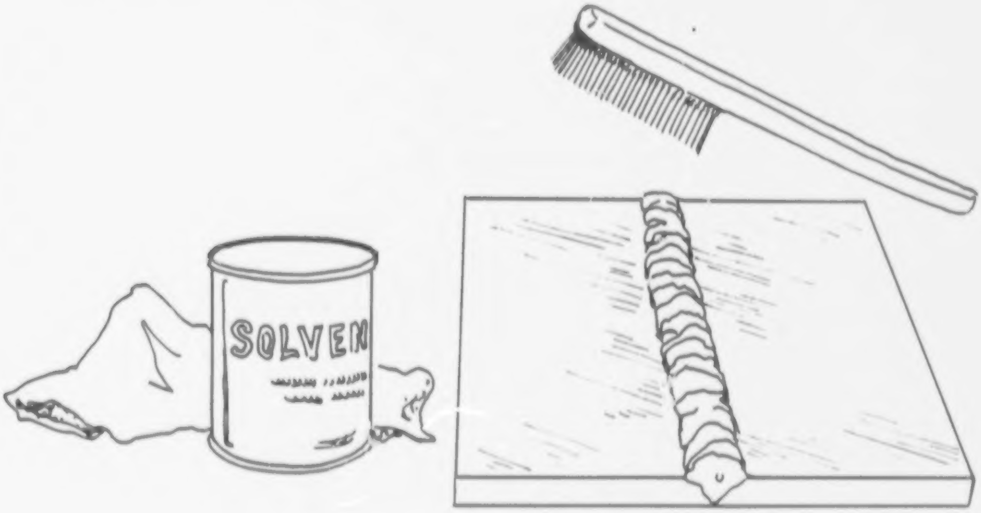
TAM #5: Nondestructive Testing

Activity #1 - Dye Penetrant Testing: Plan of Procedure

1. First, observe the instructor's demonstration of the steps in performing liquid penetrant testing.

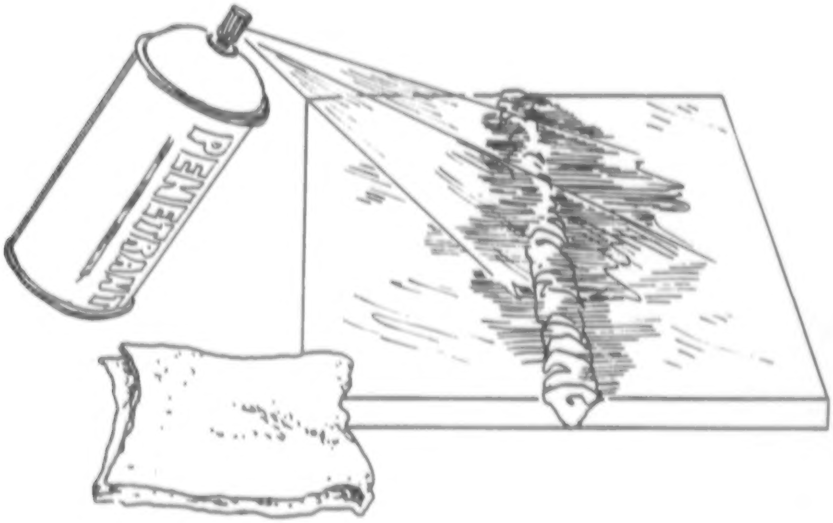


2. Put on splash-proof goggles, gloves, apron and other safety equipment.
3. Prepare the specimen's surface by cleaning thoroughly with solvent and a wire brush.



4. Quickly and lightly wipe off the excess solvent and allow the rest to evaporate.

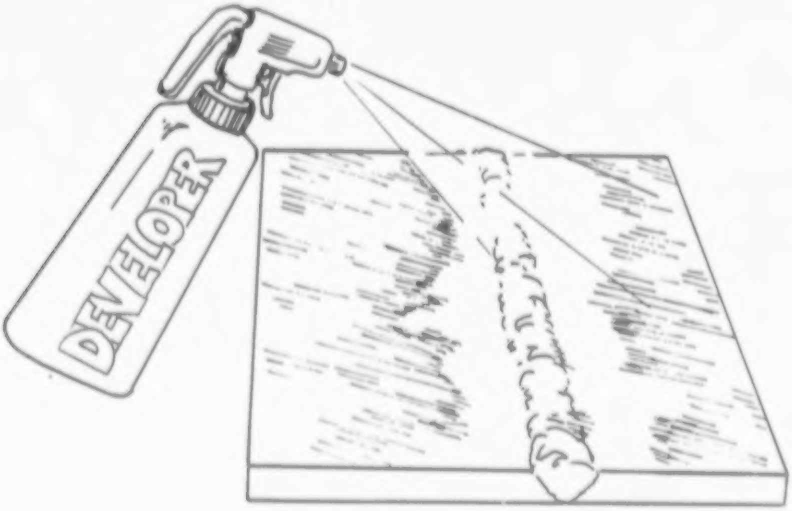
5. Apply the penetrant by any of these methods: dipping, immersing, pouring, spraying or brushing.



6. Wait for about five minutes for the liquid to penetrate. The exact time depends on the penetrant used and the type of material being tested.

7. Remove excess penetrant using any of the following as recommended in the kit:
   a. Water
   b. Solvent
   c. Post-emulsification

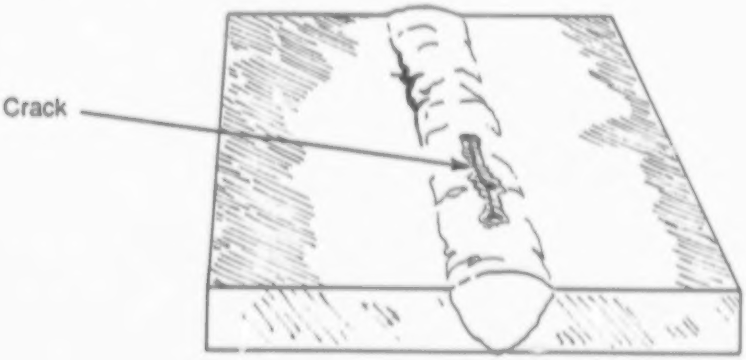
8. Apply developer to make the flaws more readily visible. Use any of these developers, as recommended by the kit:
   a. Wet, i.e., solvent-based/water-based
   b. Dry, i.e., powder form



9. Inspect the material with either normal light or with a black light (ultra-violet) when using fluorescent dye penetrants.

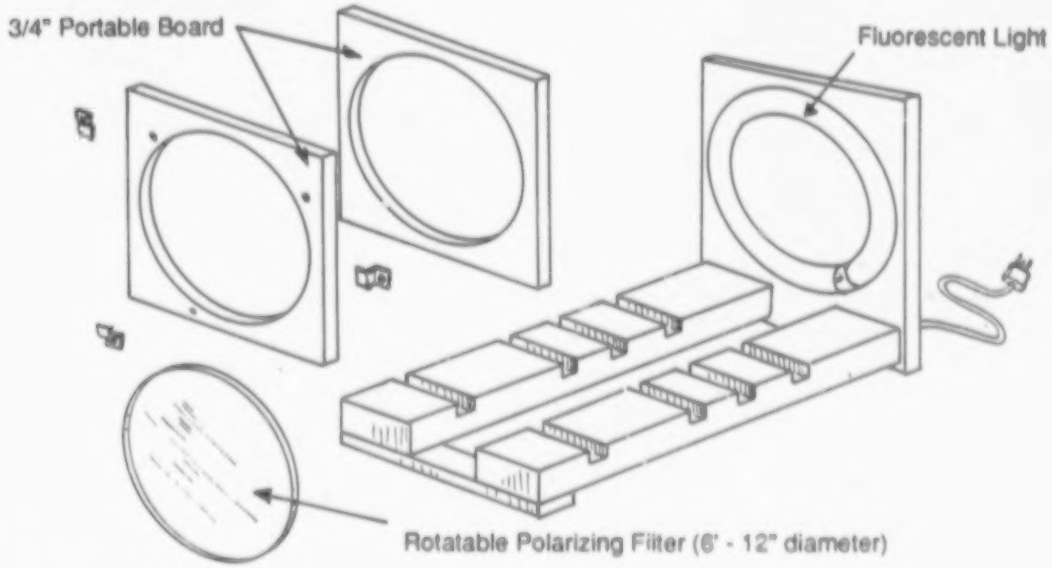
10. Interpret the stains showing on the tested item's surface.

   - The sooner the stain appears the larger and closer to the surface the flaw.
   - The larger the stain the larger the flaw.

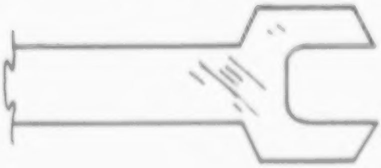


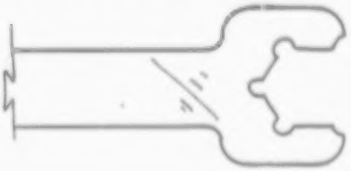
Activity #2 - Polarized Light Testing: Plan of Procedure

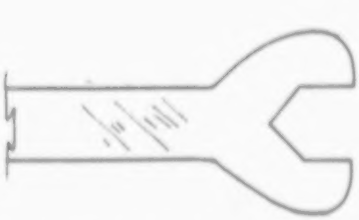
1. First, observe the instructor's demonstration of how to use the polarized light test to help design a product. The polariscope is easily built in the laboratory using polarizing filters from surplus or a company such as Edmunds Scientific.

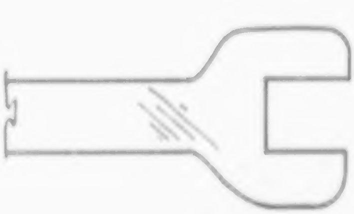

3/4" Portable Board
Fluorescent Light
Rotatable Polarizing Filter (6' - 12" diameter)

2. Prepare a model of the part to be designed using clear cast acrylic plastic. Note, most thicker acrylic sheets and/or scraps are cast. A wrench is shown and the different shapes are going to be tested to identify the best.

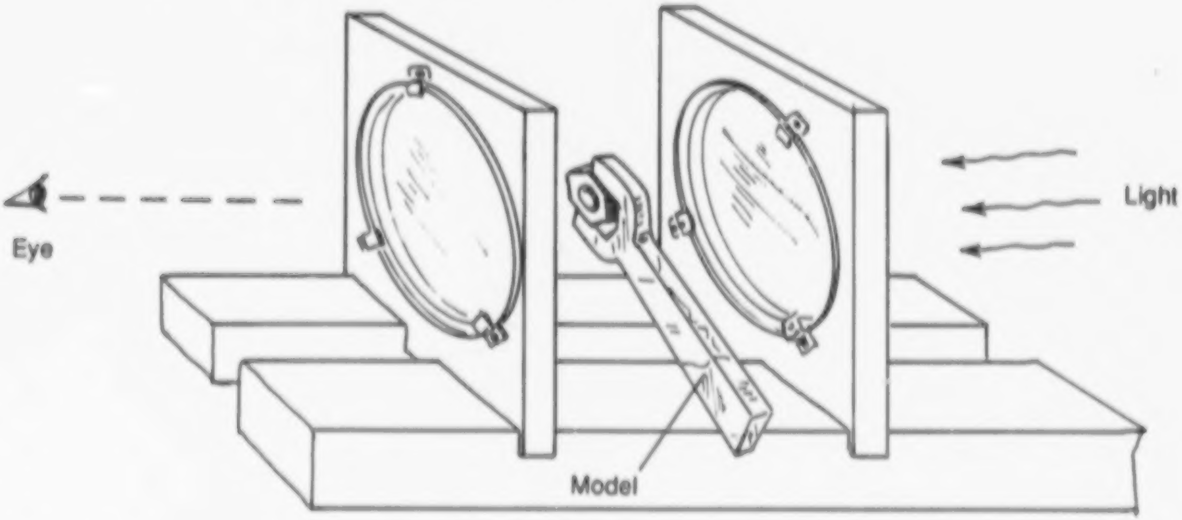






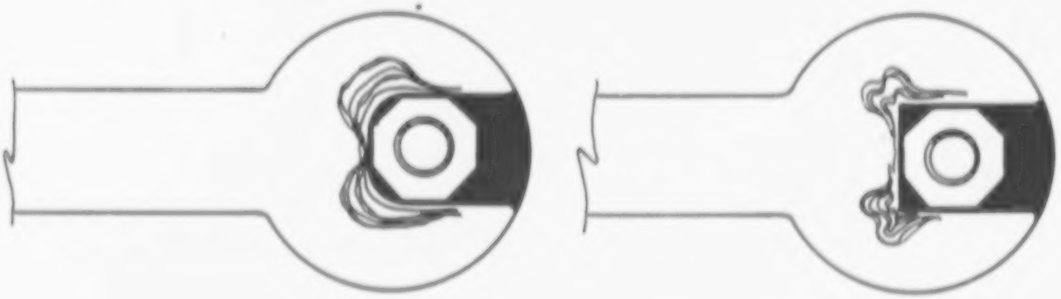


3. Place the clear plastic model between the polariscope's two filters and shine the instrument's light through them and the model.



4. Rotate the two filters until the maximum intensity of lines is seen in the specimen when it id loaded.

5. Gradually load the model with ever-increasing forces. Observe carefully for the stress lines that show. Where they are most intense and closest together, the more strain is in the sample and the more likely it is to fail.



6. Redesign the model and retest. The object is to get the most even and least concentrated distributions of the color bands that indicate stress in the sample.

7. Try using polarized light testing for any of the following:
   a. Designing the strongest bridge truss type.
   b. Establishing the strongest joint design.
   c. Identifying the optimum shape for an open-ended wrench.

TAM #5 - Summary

1. **Review & Summary Activities**

   No single TAM could hope to include all the forms of nondestructive testing which exist. However, after studying this module, you should be acquainted with some key principles of material testing with specific reference to nondestructive testing, and particularly dye penetrant and polarized light testing.

2. **Review Questions -- Test yourself!**

   A. How is the liquid penetrant test conducted?

   B. Why are clean surfaces important when using liquid penetrants to test metals for surface and subsurface defects?

   C. Explain the difference between developing and inspection.

   D. Where could polarized light testing be used appropriately?

TAM #5 - Post-assessment

Instructions:

1. Complete the self-check on the dye penetrant test.
2. Have the instructor complete the evaluation and discuss discrepancies between the two assessments.
3. Complete the Post-test for TAM #5.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #5 -- Self-check (Dye Penetrant Testing)

Course: Introduction to Materials & Processing Technology **Date:** ________

TAM# 5 **Title:** Dye Penetrant Testing

Student Name: ______________________________

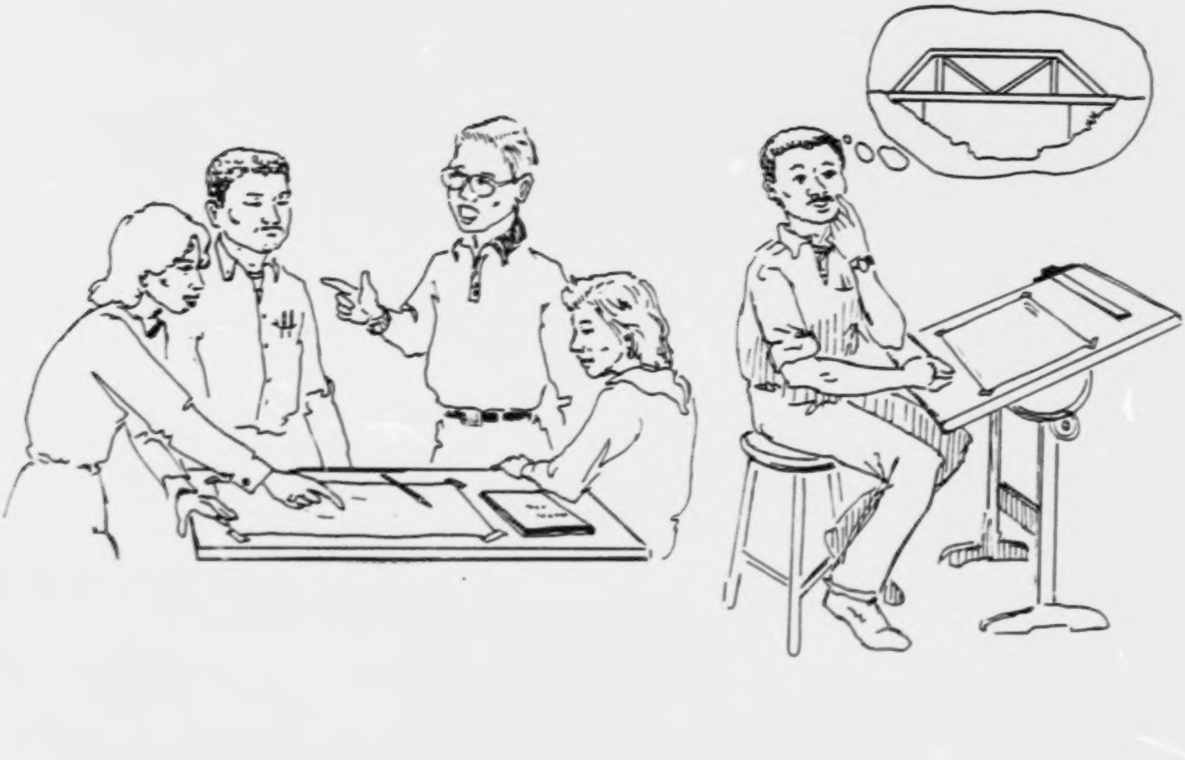
		Performance Rating				
		Poor				Excellent
TASK		1	2	3	4	5
1.	Employed proper safety procedures					
2.	Cleaned the surface with solvent					
3.	Applied penetrant properly					
4.	Removed excess penetrant					
5.	Applied developer properly					
6.	Inspecied sample and identified existing flaws					
7.	Cleaned up properly					

Total: ___

Course:	Introduction to Materials and Processing Technology

Technology Activity Module #6

Bridge Construction



TAM #6: Bridge Construction

Instructor Component

Activity Objective: The main of this activity is to use the bridge building activity as a vehicle for learning the design process and applying key engineering considerations such as strength-to-weight ratios, etc. The activity also brings to light the variety of processes necessary to the construction of a bridge. The key processes to be involved are: designing, building and testing a model bridge or truss.

Activity Competencies: By completing this TAM, the student will be able to:

1. Apply maintenance and servicing techniques to structures. [4,IV]
2. Experiment with simulated foundations to identify their load-bearing characteristics. [4,IV]
3. Identify and describe the essential features of the equipment used in construction technology. [4,IX]
4. Identify key factors related to security and site maintenance in construction technology. [4,IX]
5. Demonstrate the safe use of equipment, supplies, materials and processes that are related to construction technology. [4,X]
6. Incorporate safety and security measures into building designs. [4,X]
7. Analyze and explain the roles of management and labor as they relate to construction technology. [4,XI]
8. Participate in planning, organizing, controlling, producing and quality control construction processes. [4,XI]

Module Instructions

Introduction:

This TAM guides students through the construction and testing of a model bridge. The instructor should try to make it as realistic as possible. The activities include: design, safety, demonstrations, pre- and post-tests, bridge building, testing and analysis.

Safety Considerations:

Although only simple precautions must be observed when handling model building tools and materials, it is good practice to reinforce safety at all times. Point out the proper use of modeling knives and hot glue guns for example. Always cut away from your body and hands. Never move about the laboratory with a knife in an exposed position. Avoid touching hot melt adhesive. These are but a sample of basic safety considerations to be highlighted..

Needed Materials:

1. **Supplies**

    - Drawing paper
    - Graph paper
    - Glue (white) or hot-melt adhesive
    - #2 Pencils
    - Pre-cut wood (balsa, pine or basswood strips; straws)
    - Straight pins
    - Sand or lead shot for loading the bridge
    - Cardboard
    - Utility knife and blade
    - Brushes
    - Paints
    - Chart (large) to show results of each tested bridge

2. **Equipment**

    - Universal testing machine, or
    - Hydraulic jack with pressure gauge, or
    - Self-made bridge loading system, pail
    - Testing fixtures (bridge positioning jigs)
    - Bathroom scales for weighing loads
    - Safety glasses
    - Duplicating machine/blueprints
    - Drafting instruments
    - Modeling knives
    - Hot-glue gun

3. **Handouts**

    A. Student component of TAM #6

4. Instructional Resources

A. Books

Betts, M.R.; Hauenstein, A. F. & Fannin, J.W. (1976). Exploring the construction industry. Bloomington, IL: McKnight.

Daniel, C. (1986). Roof truss strength test. CITE Module. Muncie, IN: Ball State University, pp. 1-10.

Darrow, D. & Pine, D. (1980). Production systems. Des Moines, IA: Department of Public Instructions. pp. 205-214.

Fales, J. F. ; Kuetemeyer, V. F. & Brusic, S. K. (1988). Technology today and tomorrow. CA: Glencoe. ISBN 0-02-677020-2. pp. 366-369.

Gray, G. (1986). Constructing trusses. CITE Module CO-W-014. Muncie, IN: Ball State University. pp. 1-8.

Gemmill, L. (1987). Truss stiffness testing -- Torsion. CITE Module CO-P-019. Muncie, IN: Ball State University.

Goetsch, D. L. & Nelson, J. A. (1987). Technology and you. Albany, NY: Delmar. ISBN 0-8273-262-9. pp. 79-110.

Lux, D. G. & Ray, W. E. (1970). The world of construction. Teacher guide. Bloomington, IL: McKnight. ISBN 87345-465-0. p. 219.

Midwest Products Company. (1986). Teaching with model bridge building programs. Detailed activity module. Hobart, IN: Midwest Products Co., 400 S. Indiana Street, P.O. Box 564, Hobart, IN 46342.

Wood, J. (1987). Exploring construction technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

C. A short film on bridge construction, e.g., The building of the Arch or alternatively, the bridge building video available from the National Bridge Building Contest, c/o Mr. Arnold Bukert, 5750 S. Austin Ave., Chicago, IL 60638, (312) 581-0378.

D. Field trip to an actual bridge to identify components and design features.

Management/Logistics:

1. Related TAMS

No TAMS are directly related although TAM #4, Nondestructive testing, can certainly be used in designing optimum configurations using the polariscope.

2. Evaluation/Grading

Because of the importance of problem solving and the careful work required in bridge building, it is suggested that the instructor weight heavily the practical aspects of this TAM's activity.

3. Suggested Schedule/Time

Two to three weeks would seem appropriate for the basic bridge building activity. This is, however, the kind of activity that permits expansion or reductions in the allotted time while retaining good results. For example, using straws and hot-melt adhesive allows much to be accomplished in one or two class periods.

Key Instructional Suggestions:

1. Safety

Few safety precautions, other than following general laboratory work guidelines, are needed for this activity. The primary topic to be stressed is the handling of modeler's knives and keeping ones feet clear of the area under the bridge when load testing.

2. Motivation

Perhaps the most powerful motivational suggestion is to incorporate a competitive aspect; within the class, across classes, or even across schools. The state-wide competition during the MITEA's annual Technology Exposition and Contest is a further motivating factor.

3. Prerequisite Information

A general understanding of stress and strain is useful as is a basic knowledge of the nature of materials, joints, failures, etc.

4. Demonstrations

- Using the polariscope
- Model building/tool using techniques
- Bridge testing (load)
- Truss testing (load)

5. Reinforcement

The students' use of the overall design/problem-solving processes are best when refreshed and restudied. Trigonometry can be reinforced when working out truss designs. Static versus dynamic loading differences should be stressed and it is often advantageous to involve the school's mathematics and physics instructors.

6. Attitudes

It is important to encourage student's to take this activity seriously as a learning vehicle. It is typically so much fun, that learning could easily be relegated to second place.

7. Remediation/Enrichment

A. Remediation: Slower students should be paired with faster ones and their activities carefully monitored in order to help them develop.

B. Enrichment: Faster students should work out a vector analysis of their truss loadings. They could get assistance from the physics instructors. A research and experimentation project on joint design could also prove valuable. Deciding upon the best type of adhesive is another project suitable for advanced students.

8. Summary & Review

- The design/problem solving process
- Steps in bridge building
- Testing bridge designs
- Polarized light design findings
- Analyzing what happened

9. Review Questions & Answers *(Answers are in italics).*

A. Read each item carefully and choose the best answer.

1. In designing a problem-solving process to construct a model bridge and test its strength, you will have to:

   a. Solve a construction design problem.
   b. Draw and build a scale model of your chosen design.
   c. Be responsible for determining if your design is sound and workable.
   d. *All of the above.*

2. A built-up framework is known as a:

    a. Bridge.
    b. *Truss.*
    c. Bearing load.
    d. All of the above

3. In constructing trusses, the concepts that are reinforced consist of:

    a. Bearing load.
    b. Tension.
    c. Compression.
    d. *All of the above*

4. When designing a suspension bridge, certain considerations must be kept in mind. They are:

    a. Obstacle to be spanned.
    b. Purpose
    c. How much weights must be supported.
    d. Safety
    e. All of the above

5. In designing a prototype by polarized light, the light coming from a normal lamp vibrates:

    A. At right angles.
    B. In only one direction
    C. *In all directions*

B. Bring in some examples and analyze why have some real bridges failed.

TAM #6 - Test Keys (Bridge Construction)

TAM #6 - Pre-test answers

1. F 2. F 3. F 4. T 5. T 6. F

TAM #6 - Post-test answers

A rating scale form is used here as a post-test.

NOTE: The rating scale form is provided in the student component of this TAM.

TAM #6 - Pre-test (Bridge Building)

Instructions: Circle T for True and F for False for each of the following statements.

1. Truss strength depends heavily on its span. T F
2. Screwed/riveted joints are stronger than glued joints. T F
3. The truss' overall strength is the same even if tested upside down. T F
4. Strong trusses are not necessarily efficient. T F
5. When a beam is deflected, it curves slightly. The side on the outside of the curve is in tension. T F
6. Gussets and fishplates concentrate stresses in a bridge. T F

TAM #6: Bridge Construction

Student Component

Introduction:

Many constructed structures need long clear spaces between support columns. A built up framework, i.e., truss, is used for constructing bridges and roofs that do not need to be held up by columns or walls. Trusses are used extensively in distributing load, stiffening structures and building up strength. (Gray, 1986).

You are expected to apply basic truss patterns to support your own design in order to make your bridge as competitive as possible.

Competencies: Following the completion of this TAM you will be able to:

1. Apply maintenance and servicing techniques to structures. [4,IV]
2. Experiment with simulated foundations to identify their load bearing characteristics. [4,IV]
3. Identify and describe the essential features of the equipment used in construction technology. [4,IX]
4. Identify key factors related to security and site maintenance in construction technology. [4,IX]
5. Demonstrate the safe use of equipment, supplies, materials and processes that are related to construction technology. [4,X]
6. Incorporate safety and security measures into building designs. [4,X]
7. Analyze and explain the roles of management and labor as they relate to construction technology. [4,XI]
8. Participate in planning, organizing, controlling, producing and quality control construction processes. [4,XI]

Module Overview:

This module contains only one activity, but it is a deceptively simple one. You are to design a bridge that will meet the criteria established by your instructor. You may be assigned to work individually or in groups. Each group could, in effect, become a mini-company. Each company could select a name, logo, slogan, etc. Each individual or group will design, build, construct and test its own bridge model.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure
2. Complete the pre-test given by your instructor.
3. Do Activity #1 - Bridge Building.
4. Review and summarize.
5. Complete the post-assessment procedure.

Key Information:

1. Class Presentations

- Load distribution and vector resolution of forces
- Bridge designs
- Truss designs

2. Demonstrations

- Model building techniques
- Bridge testing/loading
- Truss testing/loading

3. Safety

In this module, all safety aspects and procedures should be carried out by each student in the laboratory during the performance of each activity. Watch out for sharp modelers' knives.

4. Personal Activity

Before beginning work on these activities, it is recommended that you read:

Betts, M.R.; Hauenstein, A. F. & Fannin, J.W. (1976). Exploring the construction industry. Bloomington, IL: McKnight.

Midwest Products Company. (1986). Teaching with model bridge building programs. Detailed activity module. Hobart, IN: Midwest Products Co., 400 S. Indiana Street, P.O. Box 564, Hobart, IN 46342.

Wood, J. (1987). Exploring construction technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

5. Other

Glossary:

Beam	A form of bridge, but usually it is much simpler in construction. A tree over a stream is the most basic form.
Bridge	An assembly of components that spans the gap between two or more abutments and supports a load while doing so.
Compression	The opposite of tension. Compression occurs when a material is being pushed together.
Creativity	The generation of new ideas or the application of ideas to new ends.
Joints	The place of intersection where bridge components are joined to one another.
Load Bearing	Holding the weight or other forces.
Member	A component of a bridge or truss.
Tension	The opposite of compression. Tension occurs when materials are being pulled apart.
Test Sling	The device used to apply load to the bridge/truss in laboratory testing.
Truss	A set of linked pieces that together distribute applied loads to where ever they can be best handled.
Truss Strength	The amount of load a truss can hold before it breaks or deforms too much.
Truss deflection	The result of stiffness. The amount the bridge/truss deflects when loaded..

Needed Materials:

1. Supplies

- Drawing paper
- Graph paper
- Glue (white) or hot-melt adhesive
- #2 Pencils
- Pre-cut wood (balsa, pine or basswood strips; straws)
- Straight pins
- Sand or lead shot for loading the bridge
- Cardboard
- Utility knife and blade
- Brushes
- Paints
- Chart (large) to show results of each tested bridge

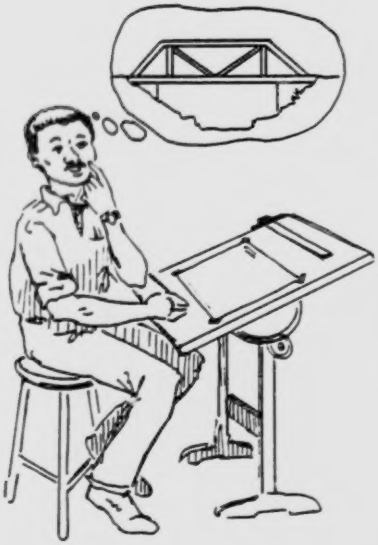
2. Equipment

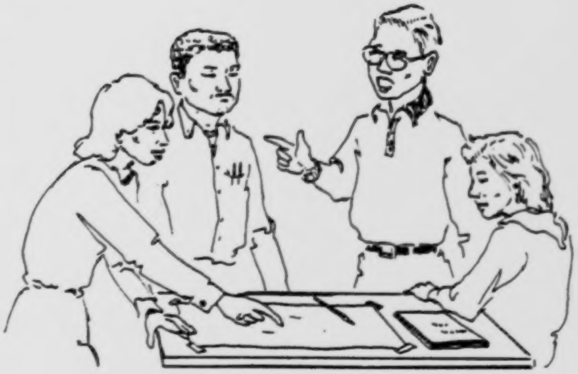
- Universal testing machine, or
- Hydraulic jack with pressure gauge, or
- Self-made bridge loading system, pail
- Testing fixtures (bridge positioning jigs)
- Bathroom scales for weighing loads
- Safety glasses
- Duplicating machine/blueprints
- Drafting instruments
- Modeling knives
- Hot-glue gun

TAM #6: Bridge Construction

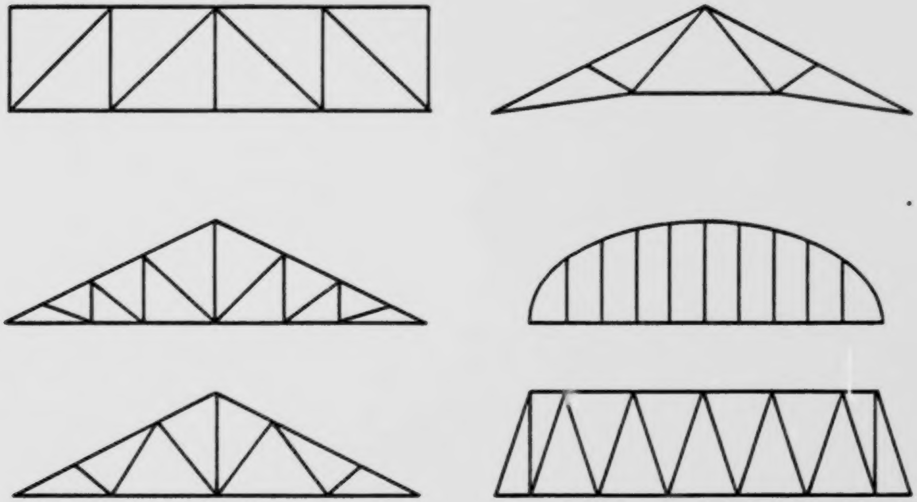
Activity #1 - Bridge Construction: Plan of Procedure

1. Identify the problem and its specifications.

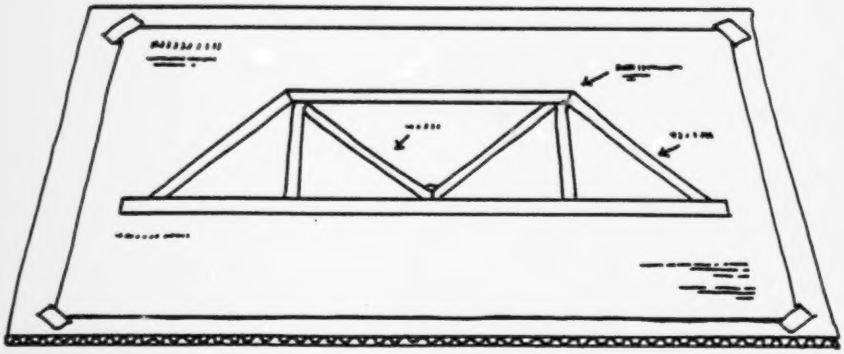




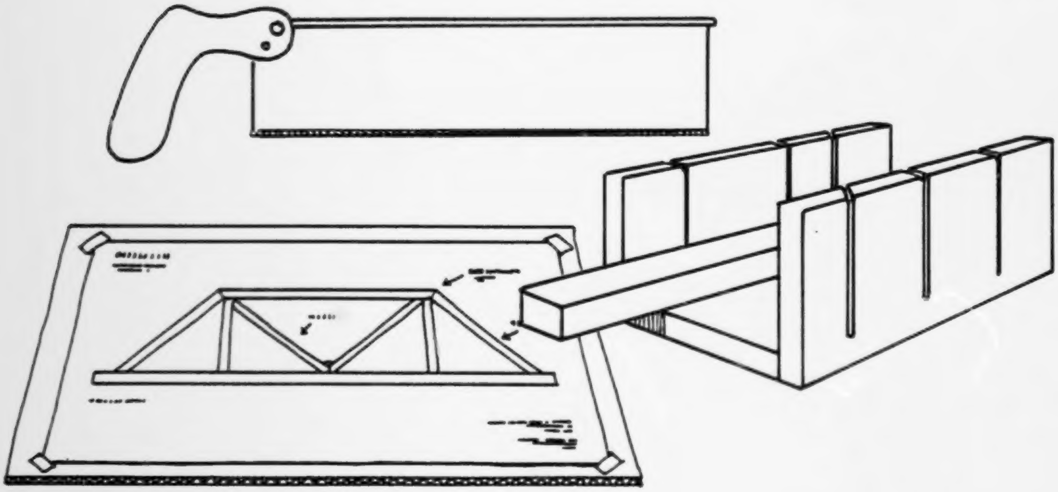
2. Research and gather data, e.g., get information about types of trusses. (illustrations adapted from Gray, 1986)



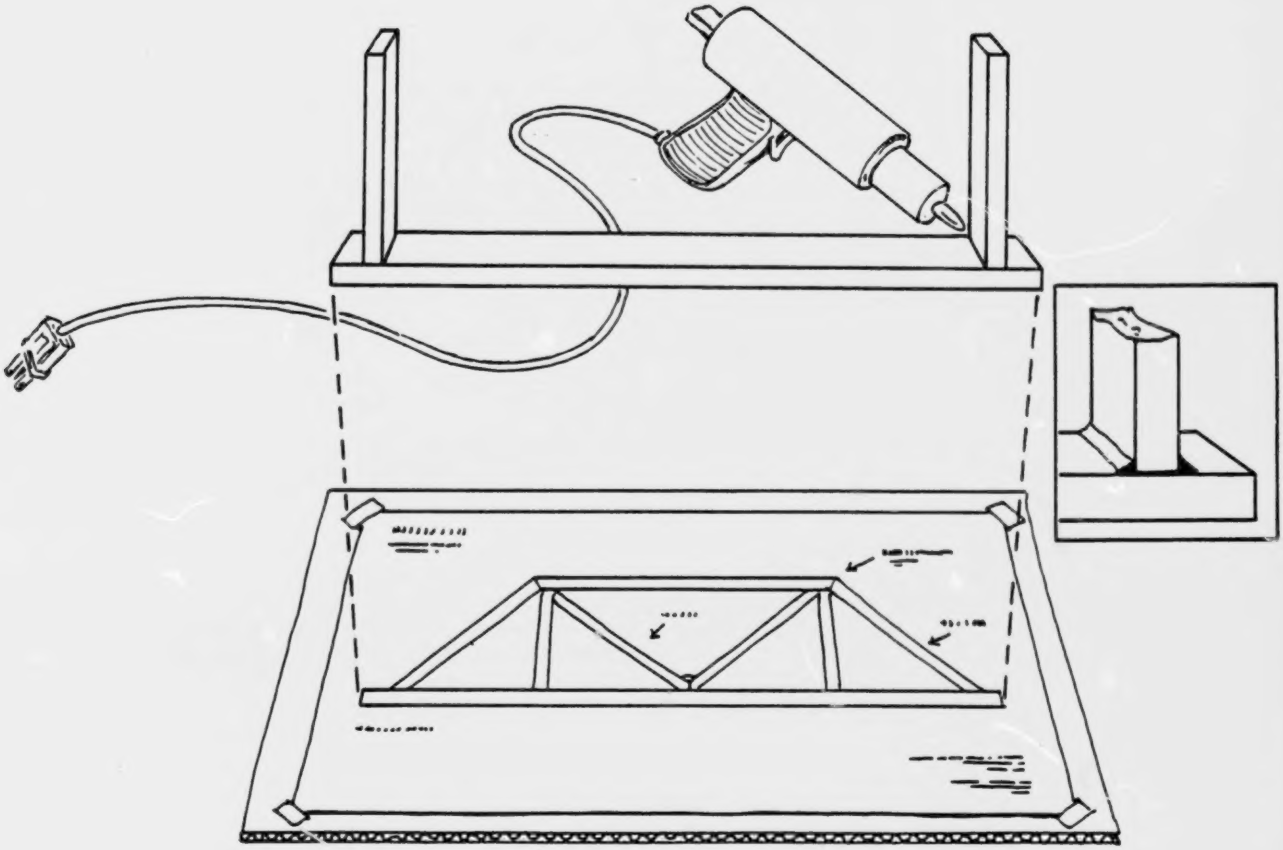
3. Develop preliminary ideas and then convert them into a sketch.
4. Formulate possible solutions and alternatives.
5. Refine the design/solution.
6. Make a full-scale working drawing.



7. Prepare a model. Using a modeler's saw and self-made miter-box, construct the sides of your scale model bridge by cutting truss members to size according to the working drawing and/or the bill of materials.
8. Place the cut pieces (truss members) over their respective locations on the working drawing.



9. Use woodworking glue (white) or hot-melt adhesive to assemble the bridge.



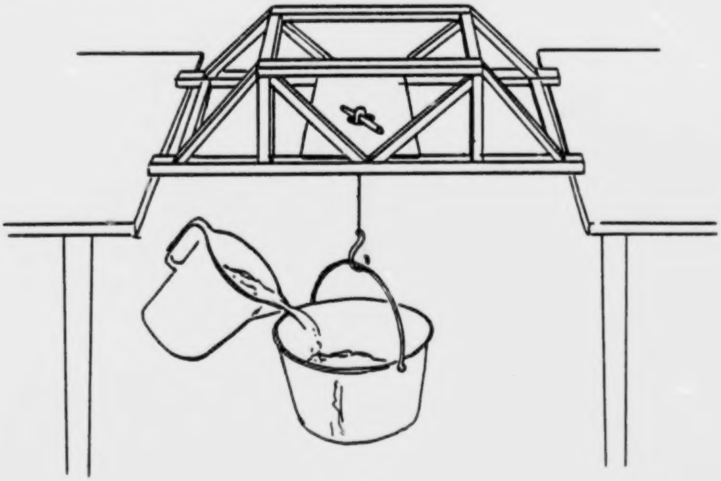
10. Use straight pins to hold the truss onto the drawing. It helps to tape the drawing to a straight piece of corrugated cardboard or other soft surface.

11. Assemble the two sides of the bridge, then glue the roadbed, top cross member and sides together to complete the bridge.

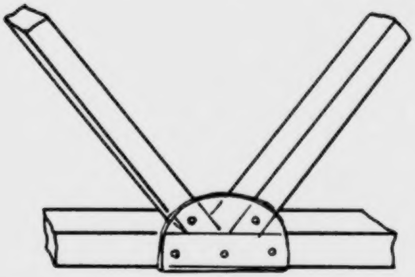
12. Weigh the bridge and record its weight on a bridge record form.

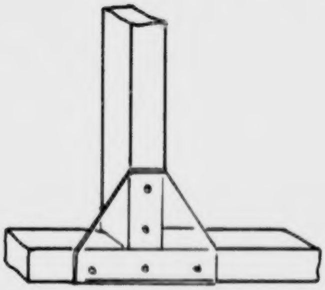
Name	Meets Requirements			Weight of Bridge	Maximum Weight Supported	Efficiency	
	Specifications	Matches Drawing	Craftsmanship			by Weight	by Length

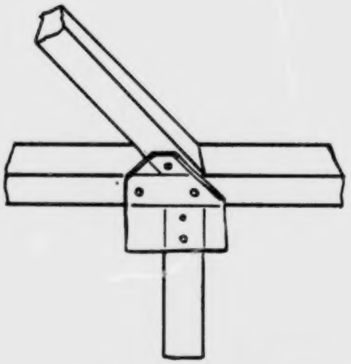
13. Analyze the design by testing the model as shown.

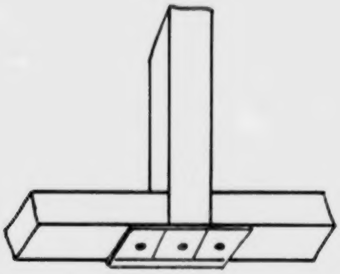


14. Experiment with model enhancements. These might include alternative truss designs, increasing bracing, adding gussets and fishplates (if permitted), changing adhesive, changing joint configuration, etc.

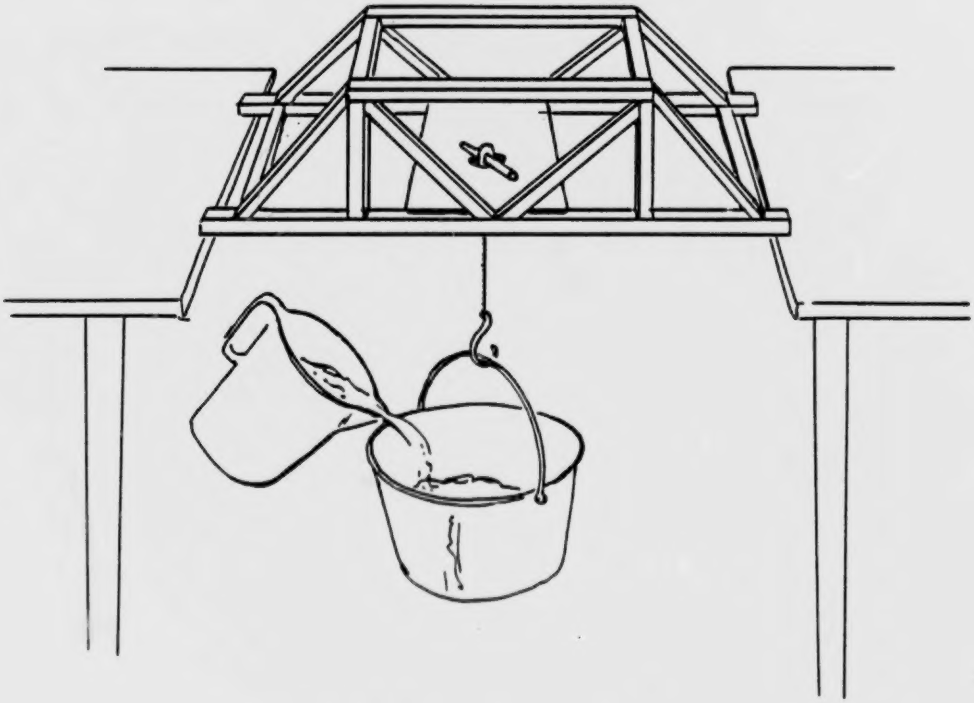








15. Detail the final/best solution and then build it carefully for the final contest!



16. Test the bridge strength by loading it on the test apparatus as shown. Record your results carefully.

17. Calculate the efficiency rating of your bridge design. Use the following formulas:

$$\text{Length efficiency} = E_L = \frac{\text{Amount of Load Causing Failure}}{\text{Length of Wood Used in Bridge}}$$

and/or

$$\text{Weight efficiency} = E_W = \frac{\text{Amount of Load Causing Failure}}{\text{Weight of Wood + Adhesive in Bridge}}$$

18. Evaluate your results and write a technical report summarizing them.

TAM #6 - Summary

1. **Review & Summary Activities**

   This module covers one of the classic projects in construction. Additionally, information on professional, technical and skilled construction career opportunities was either presented by your instructor or is available from him/her. By building the bridge individually and as part of a group, you have acted out certain jobs that are also done in real life. For example, you have worked as an engineer, construction designer, craftsman, model builder, and technician.

2. **Review Questions -- Test yourself!**

   A. What occurs when a bridge fails?

   B. How can the testing of model bridges be made more realistic?

   C. What is the difference between a though-bridge and a deck-bridge?

   D. List six different types of bridges.

   E. Identify a bridge that you have seen or know about and tell what type of bridge it is.

   F. What is a bridge truss?

TAM #6 - Post-assessment

Instructions:

1. Complete a self-check on the bridge building activity using the post-test rating scale.

2. Have the instructor complete the evaluation and discuss any discrepancies between the two assessments.

3. Complete the post-test for TAM #6

4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #6 - Post-test Rating Scale (Bridge Construction)

Course: Introduction to Materials & Processing Technology **Date:** ______

TAM# 6 **Title:** Bridge Construction

Student Name: ______________________________

Performance Rating
Poor **Excellent**
TASK 1 2 3 4 5

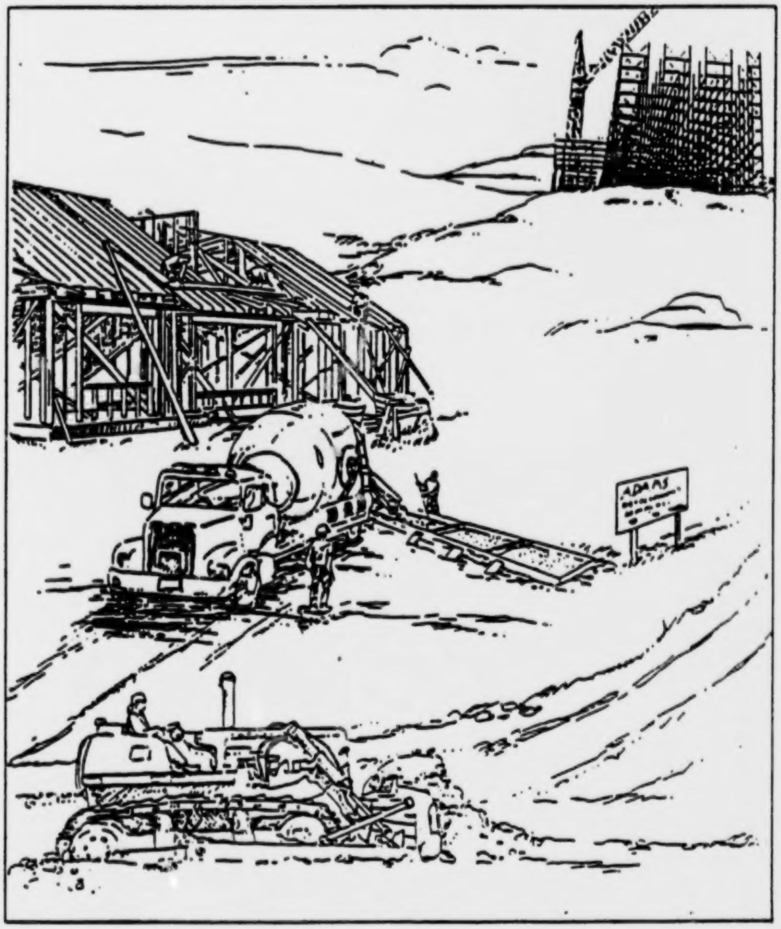
1. The problem solving process was used to develop the bridge design. .... __:__:__:__:__
2. The student worked effectively in groups. .... __:__:__:__:__
3. The original designs lead to testing of a prototype. .... __:__:__:__:__
4. Detailed plans and specifications were developed. .... __:__:__:__:__
5. The bridge model was constructed according to the plans. .... __:__:__:__:__
6. Effective construction techniques were used. .... __:__:__:__:__
7. The bridge was tested properly. .... __:__:__:__:__
8. Recommendations for improvement were systematically developed. .... __:__:__:__:__

Total: ___

Course: **Introduction to Materials and Processing Technology**

Technology Activity Module #7

Construction Projects:
Planning & Simulating



TAM #7: Construction Projects:
Planning & Simulating

Instructor Component

Activity Objective: The purpose of this module is to develop student understanding of the scope and process of construction planning, site preparation, construction and wrap-up.

Activity Competencies: By completing of this TAM, the student will be able to:

1. Identify types of construction. [4,II]
2. Describe manufactured construction techniques. [4,II,D]
3. Use symbols, lettering and building standards as published by the American Institute of Architects.
4. Design and schedule landscaping projects. [4,II]
5. Plan, design, layout and build a scale model of a model community. [4,III]
6. Use architectural drafting procedures to produce construction-related drawings such as floor plan, elevations, foundation plans, plot plans, wall sections and details. [4,III,B]
7. Identify light, heavy, industrial and civil construction processed and techniques including site preparation.
8. Demonstrate basic construction knowledge and skills. [4,IV]
9. Experiment with simulated foundations to identify their load bearing characteristics. [4,IV]
10. Identify the major types of materials and supplies used in construction technology. [4,VI]
11. Identify and describe the essential features of the equipment used in construction technology. [4,I]
12. Investigate and report on emerging tools, materials and processed in the construction industry. [4,I]
13. Estimate construction job costs and requirements. [4,VII]
14. Identify key factors related to security and site maintenance in construction technology. [4,IX]
15. Demonstrate the safe use of equipment, supplies, materials and processes that are related to construction technology. [4,X]
16. Incorporate safety, security and site maintenance into construction technology. [4,X]
17. Analyze and explain the roles of management and labor as they relate to construction technology. [4,XI]
18. Participate in the planning, organizing, controlling, producing and quality control of construction. [4,XI]

Module Instructions

Introduction:

This activity is devised to have students learn about construction technology by simulating the construction, design and underlying processes involved in constructing a highway overpass. The activities include: design, demonstration, safety, pre- and post-tests and construction of a diorama (model). Of course the subject of the model is only a suggestion. The same objectives could be accomplished by building a model community or even a railroad. Instructors would be well advised to select a project of local significance. A large contractor might even underwrite the costs if a usable model resulted.

Safety Considerations:

No safety precautions beyond normal laboratory safety procedures are anticipated for this TAM. Given that the weight of a diorama may be considerable, the instructor is advised to insure that it is built on a sturdy table with non-folding legs. If special circumstances arise, e.g., students using water and electricity in the diorama, then the teacher must incorporate appropriate safety practices such as the use of only low voltage equipment.

Needed Materials:

1. **Supplies**

   - Diorama table (approximately 30" x 60")
   - Plaster of Paris or paper-mâché supplies
   - Poster board, corrugated cardboard, and/or foam-core board)
   - Water/tempra paint
   - White glue
   - Miscellaneous modeling supplies (depending upon the project being modeled)
   - Set of actual plans for a construction project (borrow from the Missouri Highways Department office nearest you, or from a contractor)
   - Sample site survey

2. **Equipment**

   - Model train/car power supply
   - Model earth-moving and construction equipment
   - Spatula
   - Pail
   - Utility knife

3. **Handouts**

   A. Student component of TAM #7
   B. Sample construction planning forms (to be developed by the instructor)

4. Instructional Resources

A. Catalogs (construction equipment & materials)

B. Books

Betts, M. R.; Fannin, J. W. & Hauenstein, A. D. (1976). Teacher's guide for exploring the construction industry. Bloomington, IL: McKnight. 87345-583-5, pp. 12-41.

Hacker, M. & Barden, R. (1987). Technology in your world. Albany, NY: Delmar. ISBN # 0-8273-2655-6, pp. 233-246.

Henak, M. R. (1985). Exploring construction. Student manual. South Holland, IL: Goodheart-Wilcox. ISBN # 0-87006-537-8. pp. 5-21.

Henak, M. R. (1985). Exploring construction. Instructor's guide. South Holland, IL: Goodheart-Wilcox. ISBN # 0-87006-538-6. p. 5-50.

Lux, D.; Ray, W.; Blankenbaker, K. & Umstadt, W. (1982). World of construction. Bloomington, IL: McKnight. ISBN # 87345-406-5, pp. 1-14.

C. Film slides/film/video on construction, e.g., "Building the Arch"

D. Field trips

The class should visit an actual construction site other than a residential home.

E. Arrange for a contractor who is involved in the type of project the class will be simulating to come to the class twice. The first time the contractor should describe the planning processes required and the second time he/she should describe the actual flow of construction activity

Management/Logistics:

1. **Related TAMS**

   The instructor should point out that all materials and processing technology is related to construction.

2. **Evaluation/Grading**

   Student performance should be judged by how well students participate in the activity, the extent of their role playing and the amount of effort they demonstrate by bringing in related information/materials from the field. In addition, a teacher-developed checklist (specific to the project) should be used to assess the group project and the entire group should receive the same grade.

3. **Suggested Schedule/Time**

   Two weeks (minimum) to a 10 week maximum time are suggested depending upon how much weight the instructor wishes to place on construction technology.

Key Instructional Suggestions:

1. **Safety**

   Remind students of basic laboratory safety procedures. Additionally, highlight construction safety practices prior to each field trip.

2. **Motivation**

   Arrange to have the finished diorama placed on display in the school lobby, at a home builders' or related trade show. Show students pictures of previous projects. Have a local contractor/developer initiate the "project" with the class.

3. **Prerequisite Information**

   None other than assigned readings and mastery of conventional hand tools. It is important that the teacher develop a detailed project description the presents essential information to the student about what is to be modeled. Instructors are encouraged to enlist the help of advisory council members or local contractors.

4. **Demonstrations**

   Get a guest speaker to demonstrate the forms and processes used in construction project planning. Similarly, arrange for key demonstrations of actual construction processes during the students' field trip to a construction site.

5. **Reinforcement**

   A. Insure that the field trip reinforces what the students have been taught; be sure that the students discuss their observations afterwards.

   B. Show video tapes of previously visited construction sites.

6. **Attitudes**

   Reward students for realism in simulating the roles and attitudes of construction personnel.

7. **Remediation/Enrichment**

   A. Remediation: Have slower students work in teams with faster students.

   B. Enrichment: Have faster students prepare a presentation about the technological trends in the type of construction being simulated.

8. **Summary & Review**

   A. Prepare a summary of the construction planning process.

   B. Flowchart the procedures used in actually constructing a project.

9. **Review Questions & Answers** *(Answers are in italics)*

   A. Why is a site survey important to construction planning? *To establish proper location and resolve ownership questions.*

   B. What role do codes play in construction planning? *They insure safety and must be incorporated into design considerations.*

   C. Who is involved in construction planning? *Engineers, the client, cost-estimators, management and civic authorities.*

   D. What does the prime contractor do while the project is being built? *The contractor monitors the progress and quality of the subcontractor's work.*

   E. How is a construction project finished? *By cleaning up the site and having a turn-over check/inspection made.*

Date: ________ **Class:** __________________ **Name:** _________________

TAM #7 - Pre-test (Construction Projects: Planning & Simulating)

1. List five resources used in construction: [M&P, T#7, 4, V]

   a. ______________ b. ______________ c. ______________

   d. ______________ e. ______________

Instructions: Fill in the blank spaces below with the correct word(s).

2. Dividing a construction project's work into specific tasks is called: ________________. [M&P,T#7,4,XI]

3. Arranging construction tasks into the order in which they will be completed is called: ___________________. [M&P,T#7,4,XI]

4. Instructing workers to do the work is called: _______________________. [M&P,T#7,4,XI]

5. Checking to see that the work is done correctly and on time is called: ____________________. [M&P,T#7,4,XI]

6. The department that provides technical support during construction is usually called: __________________. [M&P,T#7,4,XI]

7. A construction firm's income is due to the production and achievement of the people in the_____________________ department. [M&P,T#7,4,XI]

8. The department that promotes a firm's image and what it can do is called: ____________________. [M&P,T#7,4,XI]

9. The firm's money is managed by the ___________________ department. [M&P,T#7,4,XI]

10. Worker's contracts, training and working conditions are negotiated or worked out by _________________. [M&P,T#7,4,XI]

(Henak, 1985, p. 21)

TAM #7 - Post-test (Construction Projects: Planning & Simulating)

Instructions: Match the following definitions with the correct terms.

1. ____ Includes construction and land use standards.
2. ____ Permission to use a structure.
3. ____ Makes the builder halt construction when no permit is displayed or codes are not followed.
4. ____ Describes how land is to be used.

A. Building permit B. Stop work order C. Building Codes D. Zoning Code.

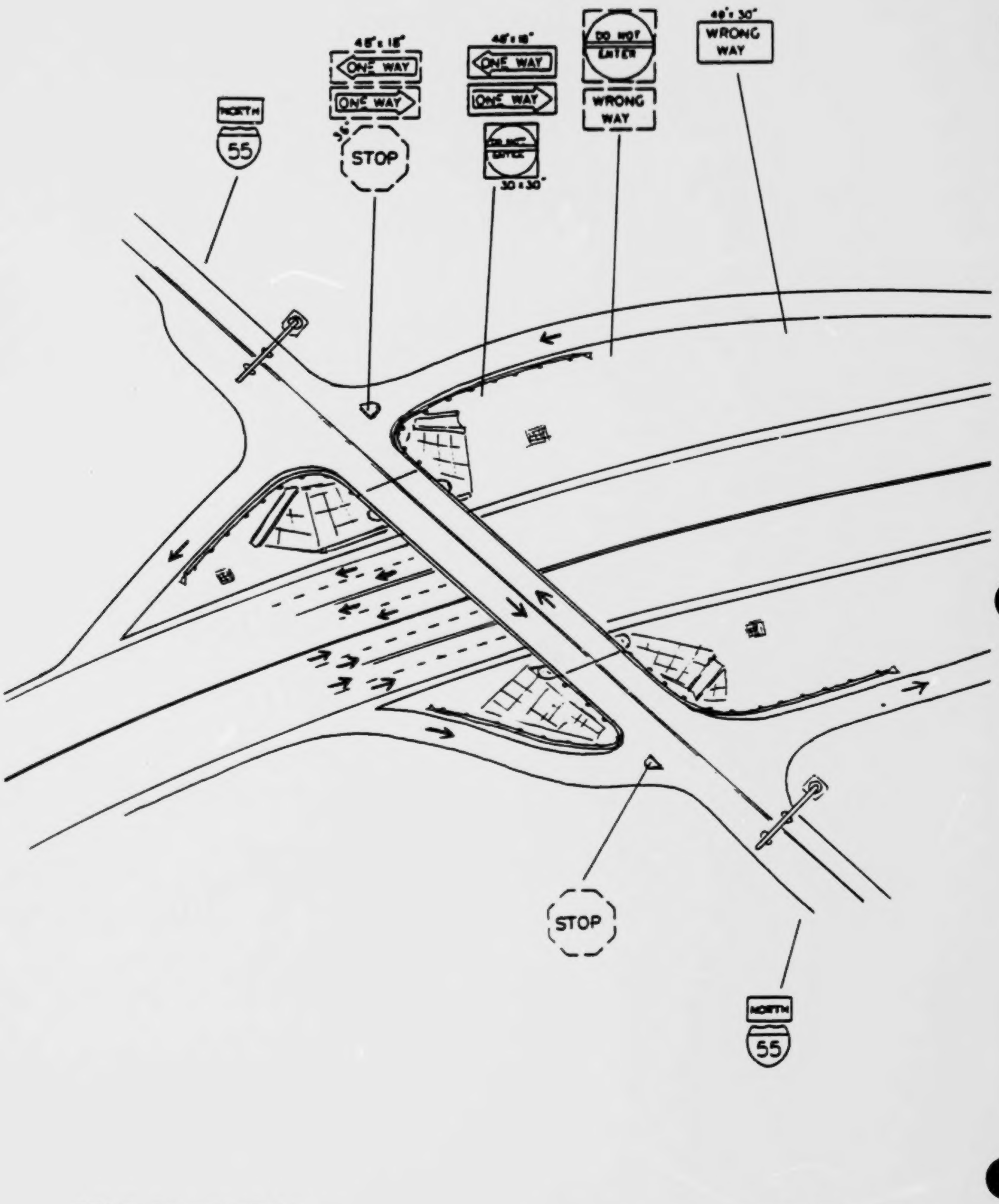
Instructions: Fill in the blanks with appropriate answers:

5. When materials or structures are reused it is called ______________.

6. Number in order the steps used to lay out a highway. The steps are given below:

Set slope stakes ____
Set elevations of centerline ____
Locate landmarks ____
Lay out width ____
Locate starting points. ____
Stake the centerline ____

The Overpass


NORTH
55
48" x 18"
ONE WAY
ONE WAY
36"
STOP
48" x 18"
ONE WAY
ONE WAY
DO NOT ENTER
30 x 30"
DO NOT ENTER
WRONG WAY
48" x 30"
WRONG WAY
STOP
NORTH
55

TAM #7- Test Keys (Construction Projects: Planning & Simulating)

TAM #7 - Pre-test Answers

1. List five resources used in construction: (the following in any order.) [M&P,T#7,4,V]

   Personnel *Money* *Equipment*

   Material *Time*

2. Dividing a construction project's work into specific tasks is called: *planning*. [M&P,T#7,4,XI]

3. Arranging construction tasks into the order in which they will be completed is called: *scheduling* . [M&P,T#7,4,XI]

4. Instructing workers to do the work is called: *directing* . [M&P,T#7,4,XI]

5. Checking to see that the work is done correctly and on time is called: *controlling the work* . [M&P,T#7,4,XI]

6. The department that provides technical support during construction is usually called: *engineering* . [M&P,T#7,4,XI]

7. A construction firm's income is due to the production and achievement of the people in the *building activity area* department. [M&P,T#7,4,XI]

8. The department that promotes a firm's image and what it can do is called: *marketing* . [M&P,T#7,4,XI]

9. The firm's money is managed by the *financial affairs* department. [M&P,T#7,4,XI]

10. Worker's contracts, training and working conditions are negotiated or worked out by *labor relations* . [M&P,T#7,4,XI]

TAM #7 - Post-test Answers

A. The diorama rating form (post-test self-check) is used as one form post-test.

B. The knowledge test is a second form of post-test

Match the following definitions with the correct terms.

1. c Includes construction and land use standards.
2. a Permission to use a structure.
3. b Makes the builder halt construction when no permit is displayed or codes are not followed.
4. d Describes how land is to be used.

   a. Building permit
   b. Stop work order.
   c. Building Codes.
   d. Zoning Code.

Fill in the blanks with appropriate answers:

5. When materials or structures are reused it is called salvage or recycling.
6. Number in order the steps used to lay out a highway. The steps are given below.

   a. Set slope stakes 6
   b. Set elevations of centerline 5
   c. Locate landmarks 1
   d. Lay out width 4
   e. Locate starting points. 2
   f. Stake the centerline 3

TAM # 7: Construction Projects:
Planning & Simulating

Student Component

Introduction:

You will be a contractor! In this TAM you will actually go through the steps used by contractors operating projects that cost hundreds of thousands or even millions of dollars. You and your classmates will make key decisions that can result in success or bankruptcy or worse! Additionally, you will develop interesting and potentially profitable modeling skills.

Competencies: Following the completion of this TAM, you will be able to:

1. Identify types of construction. [4,II]
2. Describe manufactured construction techniques. [4,II,D]
3. Use symbols, lettering and building standards as published by the American Institute of Architects.
4. Design and schedule landscaping projects. [4,II]
5. Plan, design, layout and build a scale model of a model community. [4,III]
6. Use architectural drafting procedures to produce construction-related drawings such as floor plan, elevations, foundation plans, plot plans, wall sections and details. [4,III,B]
7. Identify light, heavy, industrial and civil construction processed and techniques including site preparation.
8. Demonstrate basic construction knowledge and skills. [4,IV]
9. Experiment with simulated foundations to identify their load bearing characteristics. [4,IV]
10. Identify the major types of materials and supplies used in construction technology. [4,VI]
11. Identify and describe the essential features of the equipment used in construction technology. [4,I]
12. Investigate and report on emerging tools, materials and processed in the construction industry. [4,I]
13. Estimate construction job costs and requirements. [4,VII]
14. Identify key factors related to security and site maintenance in construction technology. [4,IX]
15. Demonstrate the safe use of equipment, supplies, materials and processes that are related to construction technology. [4,X]
16. Incorporate safety, security & site maintenance into construction technology. [4,X]
17. Analyze and explain the roles of management and labor as they relate to construction technology. [4,XI]
18. Participate in the planning, organizing, controlling, producing and quality control of construction. [4,XI]

Module Overview:

In this TAM, you will perform on two types of activities. First, you and your teammates will plan a complete construction project. Next, your team will actually construct a project following real-world construction procedures, including: organizing, controlling, monitoring, assessing and site wrap-up. During this second activity you will be responsible for producing a realistic model of the construction project.

Module Instructions:

1. Participate in your instructor's start-up activities and presentation(s) for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 - Planning a Construction Project .
4. Do Activity # 2 - Constructing a Project (modeling).
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. Class Presentations

Review the readings assigned by the instructor prior to the presentations on construction planning, project operation and follow-through.

2. Demonstrations

Be sure to ask the key questions when your instructor and/or guest speaker explain project planning, financing, start-up, operation and controlling, turn-over and wrap-up.

3. Safety

Remember to follow the general safety instructions and procedures the instructor has set for the laboratory. In addition, be certain to follow all safety procedures required by the construction sites you visit on your field trip.

4. Personal Activity

Before beginning work on these activities it is recommended that you read/scan any available of the following:

Betts, M. R.; Fannin, J. W. & Hauenstein, A. D. (1976). Teacher's guide for exploring the construction industry. Bloomington, IL: McKnight. 87345-583-5, pp. 12-41.

Hacker, M. & Barden, R. (1987). Technology in your world. Albany, NY: Delmar. ISBN # 0-8273-2655-6, pp. 233-246.

Henak, M. R. (1985). Exploring construction. Student manual._South Holland, IL: Goodheart-Wilcox. ISBN # 0-87006-537-8. pp. 5-21.

Henak, M. R. (1985). Exploring construction. Instructor's guide. South Holland, IL: Goodheart-Wilcox. ISBN # 0-87006-538-6. p. 5-50.

Lux, D.; Ray, W.; Blankenbaker, K. & Umstadt, W. (1982). World of construction. Bloomington, IL: McKnight. ISBN # 87345-406-5, pp. 1-14.

Also, review trade journals that a contractor might read. Visit one and ask for back copies. Throughout this TAM's activity you will also need to refer to your classroom copy of a construction technology textbook to get additional details about each step. Your instructor will advise which to use.

Glossary:

Architect	A person who develops construction plans and puts them on paper.
Carpenter	A person who mainly works with wood and wood products to place architects' plans into reality.
Concrete	A cement and aggregate mixture.
Construction	A form of building usually made and erected on site.
Drafter	A person who draws plans on a paper - technical details.
Masonry	Primarily a construction made of brick or concrete block.
Scale	A ratio of model to real object size. For example something that is 1/48th scale use 1" on the model to represent 48" (i.e., 4 feet) in the real world. A 20 foot wide road therefore would be 5" wide in the model.
Scale Drawings	Plans drawn other than full size but carefully proportioned.
Specifications	Sets of written standards detailing desired materials and/or practice.
Structures	Constructed articles used for a specific purpose, e.g., buildings, bridges, monuments, etc.
Topography	A visualization of ground contours according to elevation, etc.
Utilities	Services such as water, electricity, telephone, etc., coming into a structure.
Working Drawing	A set of drawings prepared by an architect and used by a builder in constructing a structure.

Needed Materials:

1. **Supplies**

   - Diorama table (approximately 30" x 60")
   - Plaster of Paris or paper-mâché supplies
   - Poster board, corrugated cardboard, and/or foam-core board)
   - Water/tempra paint
   - White glue
   - Miscellaneous modeling supplies (depending upon the project being modeled)
   - Set of actual plans for a construction project (borrow from the Missouri Highways Department office nearest you, or from a contractor)
   - Sample site survey

2. **Equipment**

   - Model train/car power supply
   - Model earth-moving and construction equipment
   - Spatula
   - Pail
   - Utility knife

3. **Handouts**

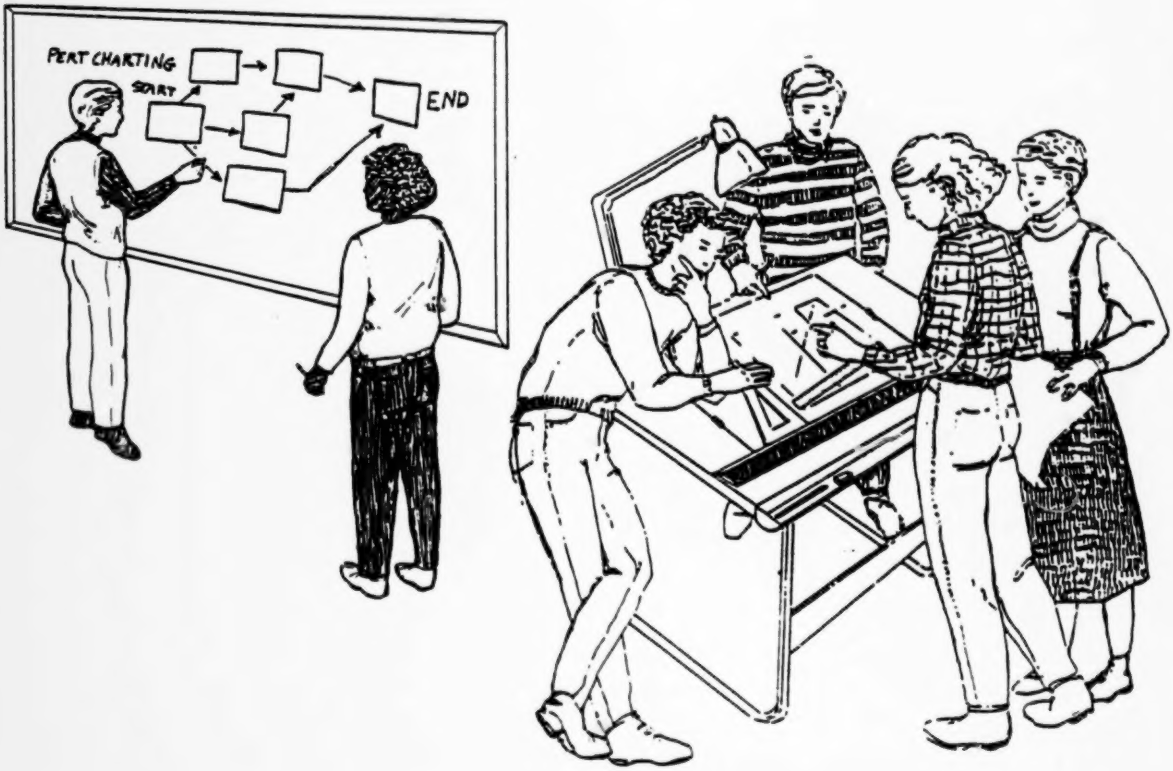
   A. Sample construction planning forms (to be developed by the instructor)

TAM # 7: Construction Projects:
Planning & Simulating

Activity #1: Planning a Construction Project: Plan of Procedure

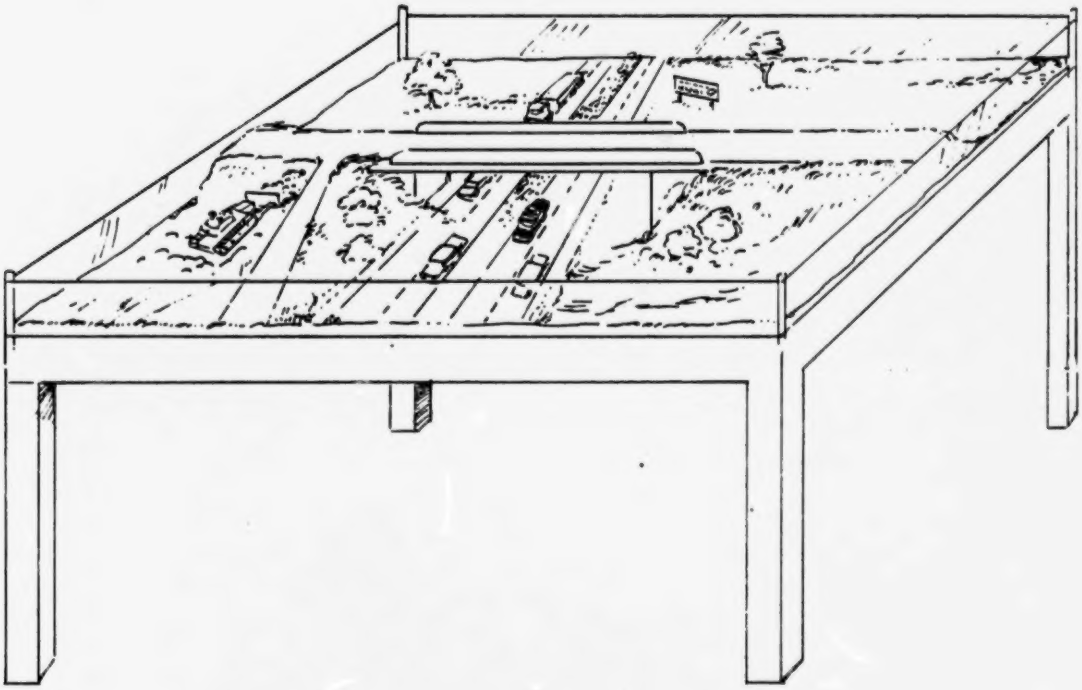
1. The planning for a construction project starts many months and sometimes years ahead of groundbreaking. It typically involves four main activities:
   a. Formulating: This is the early part of planning. It is normally done by the principal investors, operating individuals and/or groups, and it involves establishing the major aspects of the project and the overall strategy.
   b. Researching: This could involve testing materials for construction, exploring appropriate construction techniques and the like.
   c. Designing the project: This involves detailing of the essential features and specifics of the project.
   d. Engineering: This involves establishing all specific dimensions, materials, processes and checking that safety and other codes are properly met.

   Take the Project Description provided to you by your instructor and then work through each of these four stages.



2. Organizing Construction: This means putting things in the right places. It involves four important managing activities:

   a. Directing: The coordinating of people and supplies to get the project built.
   b. Monitoring: Observing that the work in progress follows the schedule and quality standards.
   c. Reporting: Informing management, the client and other contractors appropriately.
   d. Correcting: Insuring that all necessary adjustments and repairs are made as needed.



Organize your project team and assign responsibilities for each of these activities. Then, simulate the activities with respect to the project you are constructing. The table top construction site shown above is going to be your miniature world. Make it as realistic as possible! The documents that you will need to develop include at least:

a. A set of engineering drawings
b. A schedule for each step of the project
c. A plan for construction of the project
d. One bid package and response
e. Specification of the quality checks that will be employed

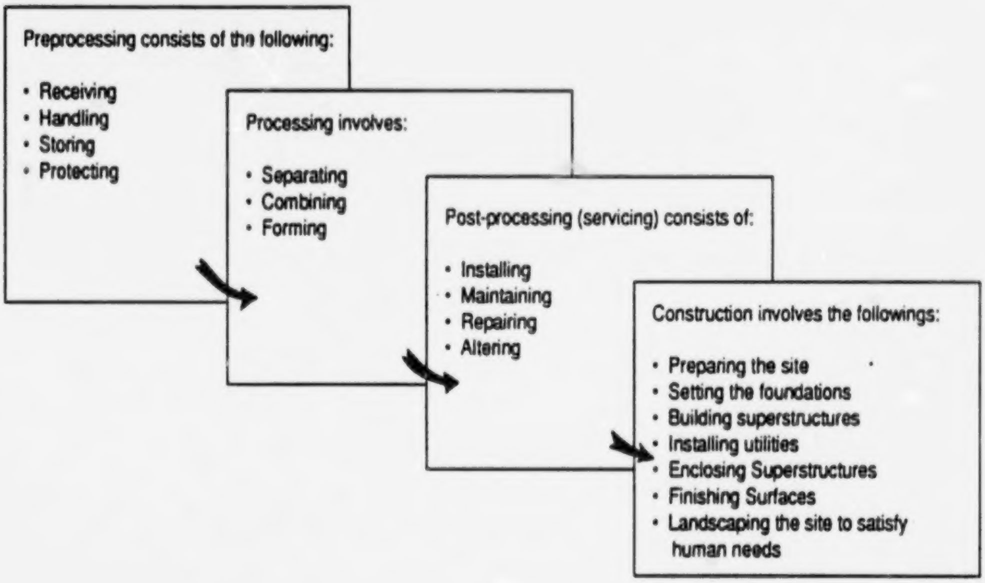
3. Personnel Technology: This section consists of the five main areas listed below and your team will need to develop a policy for each of these activities. Compile them in a company personnel manual.
    a. Hiring - Job application and interview.
    b. Training - Student is to develop a resume.
    c. Working - Time card.
    d. Advancing - Profit sharing.

TAM # 7: Construction Projects:
Planning & Simulating

Activity #2: Constructing a Project (modeling): Plan of Procedure

The actual simulation of the construction process will involve your team members in different roles than they played in Activity #1. Now you will actually build the project, albeit on a diorama table. To properly simulate real construction technology, show your instructor how you incorporated all of the following procedures into your simulation. Keep careful records and produce a binder that documents the entire simulation. Consult modeling magazines and/or your instructor for advice on how to build models.

The following points (1 - 4) describe the sequence and nature of what your are to do. The illustrations at the end of the project description document show you the actual model you are to build.


Preprocessing consists of the following:
• Receiving
• Handling
• Storing
• Protecting
Processing involves:
• Separating
• Combining
• Forming
Post-processing (servicing) consists of:
• Installing
• Maintaining
• Repairing
• Altering
Construction involves the followings:
• Preparing the site
• Setting the foundations
• Building superstructures
• Installing utilities
• Enclosing Superstructures
• Finishing Surfaces
• Landscaping the site to satisfy human needs

1. Pre-processing consists of site preparation in addition to the following:

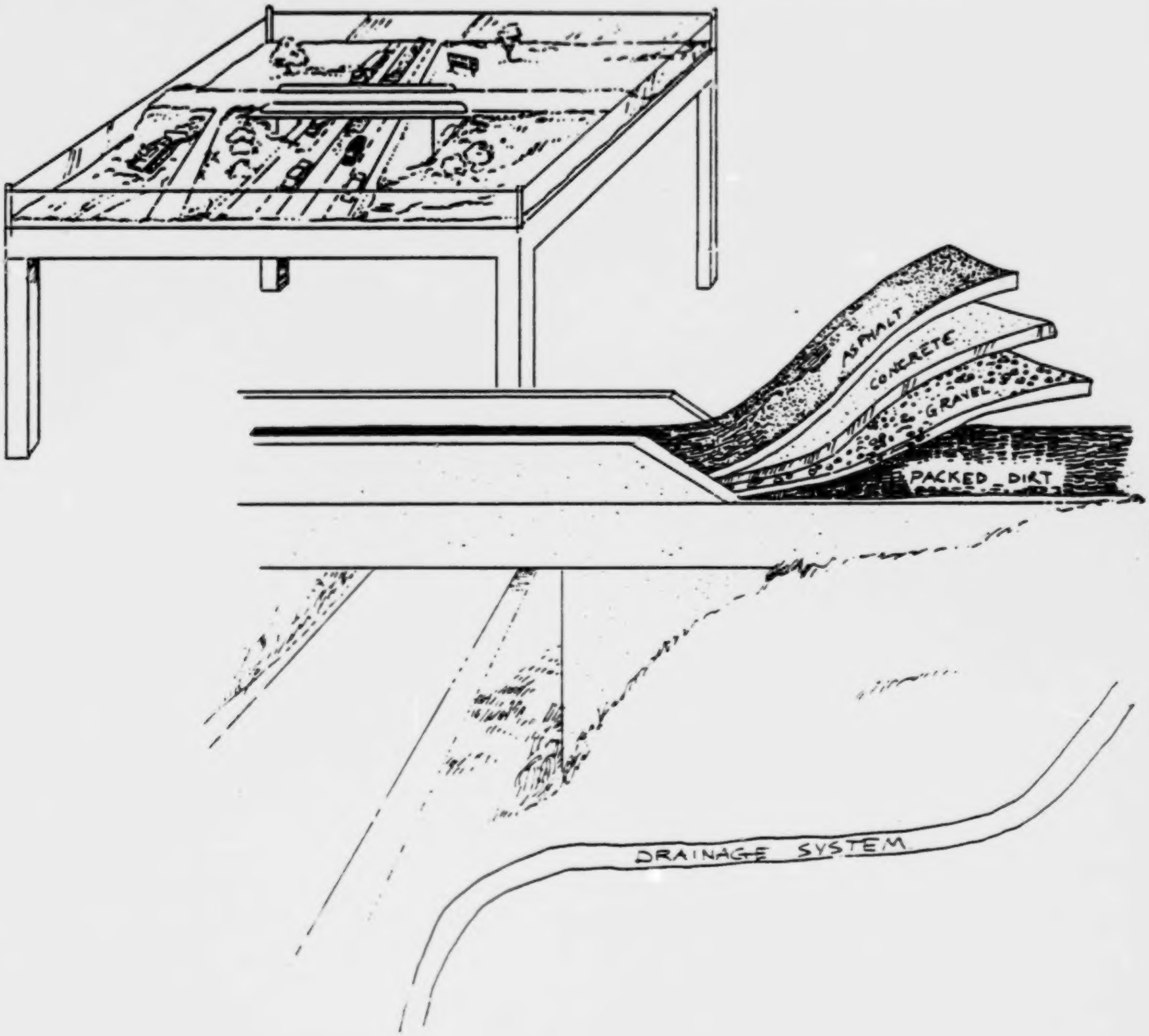
    a. Receiving
    b. Handling
    c. Storing
    d. Protecting

2. Processing involves the actual construction phase of the project. Typically it has the contractor using these processes:

    a. Separating
    b. Combining
    c. Forming

3. More specifically, however, construction involves the following steps, most of which you will model and/or adapt:

   a. Preparing the site
   b. Setting the foundations
   c. Building superstructures
   d. Installing utilities
   e. Enclosing superstructures
   f. Finishing surfaces
   g. Landscaping the site to satisfy human needs (Lux; et al., 1982.)



4. Post-processing (servicing) consists of the activities listed below. You will not, however, be asked to model these because of time constraints.

   a. Installing
   b. Maintaining
   c. Repairing
   d. Altering

TAM # 7 - Project Description Handout (Highway Overpass Diorama)

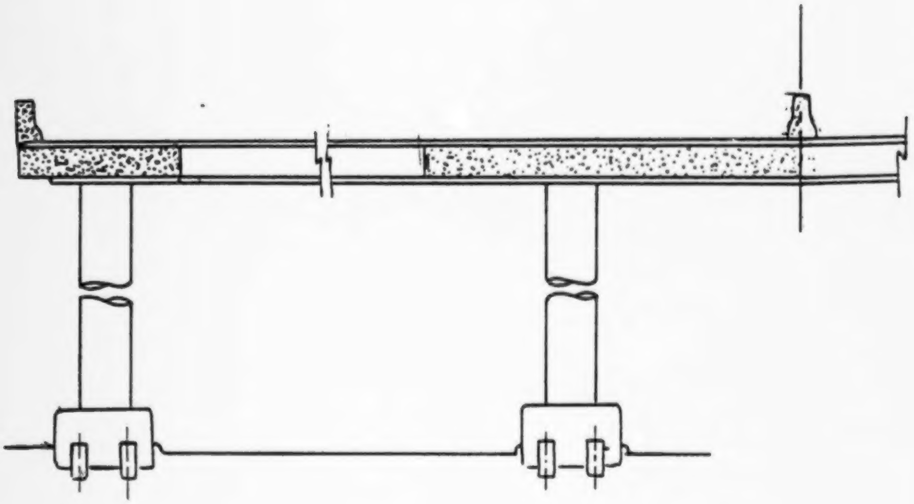
Project Description

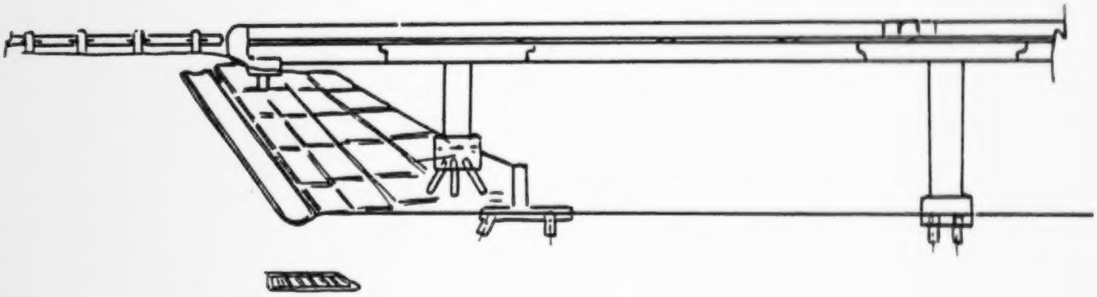
Build a table-top model (diorama) that faithfully represents an interstate highway intersection/overpass. Maximum size is 24" x 48". Select a scale that will result in a model within this range.

Characteristics

1. Show roadbed and substructure under the highway by providing a cross-section somewhere on the model.
2. Show the layers of paving materials in the roadbed.
3. Provide working lights and traffic control signals at the exit ramps.
4. Build a realistic bridge that models reality in all essential features, e.g., abutments, foundations, piers, girders, expansion joints, etc.
5. Build demonstration cross-sections of the bridge and abutments.
6. Grade/contour the surrounding terrain and landscape it.
7. Incorporate provision for site drainage.
8. Bid out any subcontract work.

Overpass Details





TAM # 7 - Summary

1. **Review & Summary Activities**

   In this TAM you have simulated how humankind produces its buildings, roads and cities. There is obviously much more to it than you were able to simulate, but you have started to see how it's done. Hopefully you were challenged and now have an interest in learning more about this key aspect of our economy.

   Review your notes and readings before taking the post-test.

   Follow-up any remaining questions with the industrial contacts who demonstrated and/or provided the field trips.

2. **Review Questions -- Test yourself!**

   A. What occurs when planning a construction project?

   B. Why is a bid process usually used?

   C. What are the steps in actually constructing a project?

TAM #7 - Post-assessment

Instructions:

1. Complete the self-check on the construction project model you built.
2. Have the instructor also complete the evaluation and discuss discrepancies between the two assessments.
3. Complete the post-test for TAM # 7.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

TAM #7 - Post-test Self-Check
(Construction Projects: Planning & Simulating)

Course: Introduction to Materials & Processing Technology **Date:** ________

Tam# 7 **Title:** Construction Projects: Planning & Simulating

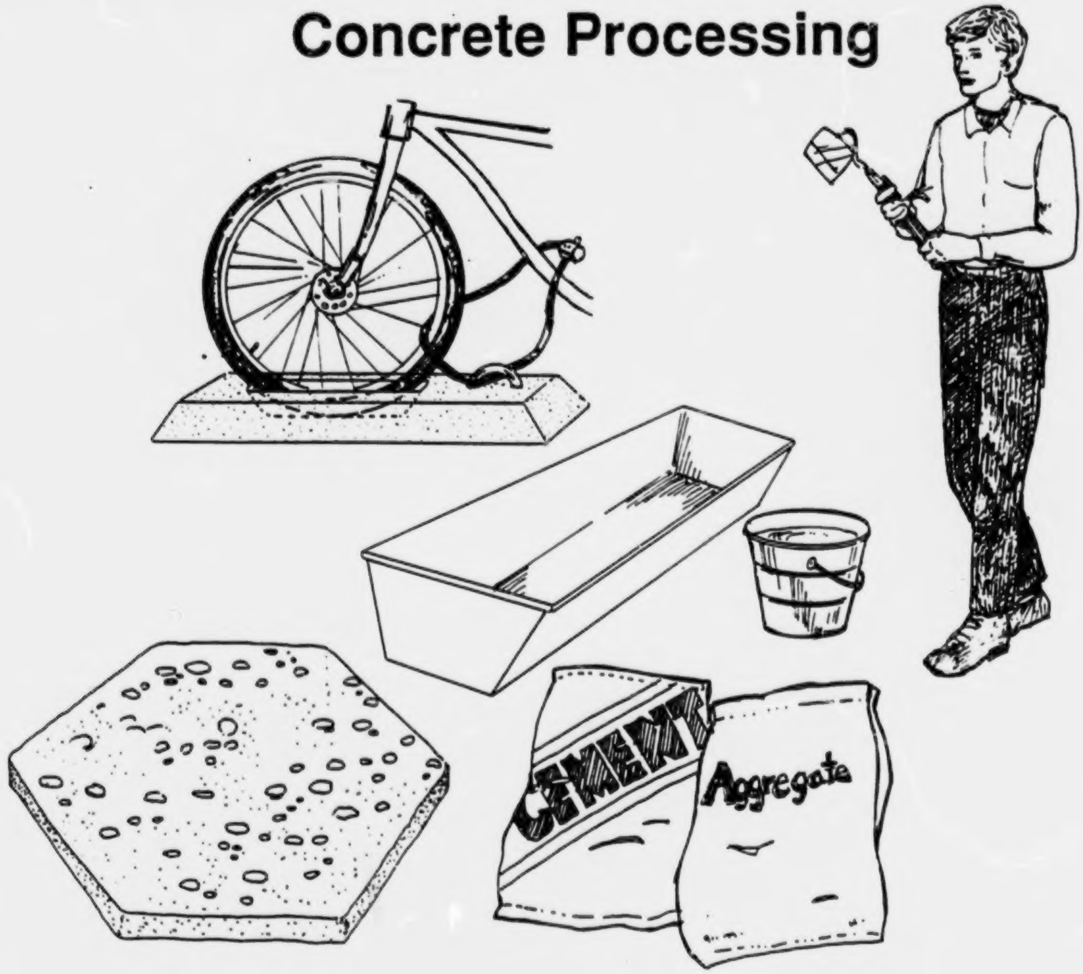
Student Name: ______________________________

TASK	**Performance Rating** **Poor** **Excellent** **1 2 3 4 5**
Diorama Project	
1. Key planning processes were identified.	_:_:_:_:_
2. Students simulated appropriate roles.	_:_:_:_:_
3 Real world resources were incorporated.	_:_:_:_:_
4. Construction processes were accurately simulated	_:_:_:_:_
5. Appropriate documentation was developed.	_:_:_:_:_
6. The finished product is realistic.	_:_:_:_:_
7. ____________________	_:_:_:_:_
8. ____________________	_:_:_:_:_
9. ____________________	_:_:_:_:_
10. ____________________	_:_:_:_:_
	Total: ___

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #8

Concrete Processing



TAM #8: Concrete Processing

Instructor Component

Activity Objective: **The purpose of this activity is to introduce the student to a set of traditional processes involved in processing concrete. These processes include mixing of raw materials, product design, finishing and testing.**

Activity Competencies: By completing this TAM, the student will be able to:

1. Demonstrate the safe use of equipment, supplies, materials and processes in construction technology. [4,III]
2. Demonstrate basic construction knowledge and skills. [4,V]
3. Experiment with simulated foundations to identify their load bearing characteristics. [4,V]
4. Identify the major types of materials and supplies used in construction technology. [4,VI]
5. Identify and describe the essential features of the equipment used in construction technology. [4,VII]
6. Investigate and report on emerging tools, materials and processes in the construction industry. [4,VII]

Module Instructions

Introduction:

This activity is designed to have students combine design, fabrication and processing methods involved in making concrete products. Although only small products are envisioned, the principles apply to major projects as well. It is suggested that the activity be combined with appropriate classroom presentations of concrete materials and processing technology. Initial activities should include a pre-test, safety instruction and demonstrations of processes and procedures. If possible a field trip to a concrete products firm should be arranged.

Safety Considerations:

The safe handling of concrete and its constituent materials demand that special attention be given to appropriate safety instruction, including apparel and safe handling practices. Gloves and safety glasses are required at all times and it is recommended that students wear coveralls or old clothes. Concrete/cement can irritate the skin and it must be kept out of the eyes -- have students wear goggles to guard against splashes.

Needed Materials:

1. Supplies

- Portland cement
- Aggregate - size to suit project
- Clean water
- Reinforcing rod/wire
- Clean sand
- Zonolite or plastic beads
- Concrete pigment

2. Equipment

- Mixing trough
- Hoe (hand and/or full size)
- Garden hose & nozzle
- Slump test cone & rod
- Concrete smoothing stone
- Pails
- Hand trowels & floats
- Edging tool
- Bristle broom

3. Handouts

A. Student component of TAM #8
B. Exposed aggregate handout

4. Instructional Resources

A. Film/video (selected from the Portland Cement Association or a contractors' association list)

B. Books and Articles

________. (n.d.). Concrete materials proportioning. Columbia, MO: University of Missouri-Columbia, Instructional Materials Laboratory. 10-7153-A

Mehta, P. K. (1986). Concrete: Structure, properties and materials. Englewood Cliffs, NJ: Prentice Hall. ISBN # 0-13-167115-4-01, pp. 8-11, 171-174, 220-320, 390-411.

Neville, A. M. (1973). Properties of concrete. New York: Wiley. ISBN # 0-470-63281-X, pp. 186-195.

White, G. R. (ed.). (1975). Basic concrete construction practices. New York: Wiley. ISBN # 0-471-67430-0, pp. 95, 253-272.

C. A guest lecturer from a local concrete contractor or supplier.

Management/Logistics:

1. Related TAMS

TAM #7, Construction Planning & Simulation; TAM #6, Bridge Construction.

2. **Evaluation/Grading**

Assess the student's performance by the quality of the product they produce, both in design and execution. Be sure to consider the quality of the mold/formwork employed as well as the actual mixing and pouring procedure.

3. **Suggested Schedule/Time**

Two weeks would be reasonable for most products.

Key Instructional Suggestions:

1. **Safety**

Cement mixtures are irritating to the skin so avoid contact by using gloves and washing off any splashes immediately. Splash-proof eye protection is particularly important because students will not perceive the danger because no power tools are involved.

2. **Motivation**

It may be a challenge to get students excited about concrete simply because they see so much of it that they take it for granted. Point out how easy it is to work, how useful it is and the potential for income if one knows the basics.

3. **Prerequisites**

No physical skills other than a basic capability with laboratory tools and mastery of general safety procedures. Additionally, a basic mathematical capability with proportions and the ability to size material requirements upwards or downwards is desirable.

4. **Demonstrations**

The instructor should give the following demonstrations:

- Proportioning and mixing ingredients
- Performing a slump test
- Forming a foundation pier
- Pouring and finishing a product
- Exposing aggregate

5. **Reinforcement**

This TAM lends itself well to the reinforcement of mathematics competencies involving proportions and ratios. Interact with the school's math instructors to see how this can best be accomplished. Additionally, conversions between units of length, volume and weight are important. Yet another reinforcement possibility is to deal with the chemical processes (formulas) involved in cement setting.

6. Attitudes

The key attitudes to be encouraged are those pertaining to safety. However, this TAM provides a good opportunity to make the point that students should not take even the most common materials for granted -- there is a lot to learn!

7. Remediation/Enrichment

A. Remediation: Have slower students perform drill and practice routines, preferably on a computer, until they master the sizing of mixes to suit a product.

B. Enrichment: Have advanced students research the new concrete technologies such as the combining of concrete with fiber/plastic mixtures. Then have them prepare samples of such mixtures and compare their properties.

8. Summary & Review

Highlight the key processes used in making cement and concrete products. Review the key steps in making a product in the laboratory.

9. Review Questions & Answers (*Answers are in Italics*)

A. How is cement made? *By heating gypsum then grinding the clinker.*

B. Why is it necessary to proportion mixes accurately? *It is the ratio of components that determine the strength of the final concrete product.*

C. What are the key factors that result in a quality concrete product? *Proper component proportion, careful mixing of ingredients, careful placing of material and effective product design.*

D. How does one test concrete mixtures and products? *Many tests are available but the slump test and compression test are the most commonly used.*

E. How can one strengthen concrete products? *By incorporating reinforcement materials and/or increasing the proportion of cement.*

TAM #8 - Test Keys

TAM #8 - Pre-test Answers

1. b, d   2. b   3. a   4. d   5. d   6. c   7. d

TAM #8 - Post-test Answers

1. d   2. b   3. e   4. c   5. d   6. d   7. d

Date: _____ **Class:** ____________________ **Name:** ____________________

TAM #8 - Pre-test

Instructions: Circle the letter(s) that correctly completes the sentence.

1. Concrete is classified as:
   a. an organic material.
   b. a ceramic material.
   c. a metallic polymer.
   d. a composite material.

2. In terms of mechanical qualities concrete:
   a. has good fatigue strength.
   b. has good compressive but poor tensile strength.
   c. has extremely low impact strength.
   d. is only moderately chemically resistant.

3. Cement is:
   a. mined in natural form in remote regions of South America.
   b. a chemical product made from gypsum.
   c. a substance made from sand.
   d. extremely expensive.

4. The term entrain means:
   a. to form into a given shape.
   b. a form of transportation.
   c. to combine reinforcement in concrete mixtures.
   d. to distribute something evenly throughout the concrete mixture.

5. Correct safety procedures for working with concrete include:
   a. splash-proof safety glasses.
   b. gloves.
   c. washing off of all splashes
   d. all of the above.

6. Concrete is made by:
   a. heating silicates to very high temperatures.
   b. a chemical reaction between lime and aggregate.
   c. mixing cement, aggregate and water.
   d. extraction from the earth in its natural form.

7. Key elements in concrete product design include:
   a. functional considerations.
   b. recognition of its compressive strength.
   c. concern for proportion.
   d. all of the above.

Date: _____ **Class:** ____________________ **Name:** ____________________

TAM #8 - Post-test

Instructions: Circle the letter that correctly completes the sentence.

1. A slump test is used to:
    a. calculate the strength of concrete.
    b. estimate concrete cost.
    c. prepare concrete for pouring.
    d. indicate the workability of a concrete mixture.

2. In terms of mechanical qualities, concrete:
    a. has good fatigue strength.
    b. has good compressive but poor tensile strength.
    c. has extremely low impact strength.
    d. is only moderately chemically resistant.

3. Which is not a typically used aggregate?
    a. stone
    b. gravel
    c. sand
    d. slag
    e. none of the above

4. The term admixture means:
    a. the liquid added to cement.
    b. anything added to cement.
    c. anything added to a concrete mixture other than cement, water & aggregate.
    d. chemical treatment of concrete after it is set.

5. Correct safety procedures for working with concrete include:
    a. splash-proof safety glasses.
    b. gloves.
    c. washing off of all splashes.
    d. all of the above.

6. Concrete product surfaces can be finished using:
    a. mechanical marking such as sweeping.
    b. troweling.
    c. painting.
    d. expose aggregate.
    e. all of the above.

7. Key elements in concrete product design include:
    a. functional considerations.
    b. recognition of a lack of tensile strength.
    c. concern for proportion.
    d. all of the above.

TAM #8: Concrete Processing

Student Component

Introduction:

Concrete is an extremely useful and versatile industrial material. When formed into various shapes and framed with other materials, its usefulness extends from the home to skyscraper to boats -- yes!-- and much more. This module will involve you in the process of working with concrete. You will create a product of your own design, perhaps even using concrete in combination with other materials. The principles, materials and tools that you will use in this activity are used daily in industry.

Competencies: Following the completion of this TAM, you will be able to:

1. Demonstrate the safe use of equipment, supplies, materials and processes in construction technology. [4,III]
2. Demonstrate basic construction knowledge and skills. [4,V]
3. Experiment with simulated foundations to identify their load bearing characteristics. [4,V]
4. Identify the major types of materials and supplies used in construction technology. [4,VI]
5. Identify and describe the essential features of the equipment used in construction technology. [4,VII]
6. Investigate and report on emerging tools, materials and processes in the construction industry. [4,VII]

Module Overview:

This module contains two related activities.

1. Activity #1 will be to make concrete mixtures of various proportions and perform slump and strength tests on them.
2. Activity #2 will be to design and fabricate a concrete product. Several options are presented for you although your instructor may allow/encourage alternative projects. The options are:
   - An exposed aggregate patio block
   - A sample house footing
   - A downspout splash block
   - A bicycle stand
   - Concrete sign or marker
   - Parking bumper
   - Bird bath or fountain
   - Outdoor bench frame

Additional information will be provided to you by instructor demonstrations.

Key Information:

1. Class Presentations

- Concrete, its components and how it works
- Chemical and mathematical prerequisites
- Concrete properties and design

2. Demonstrations

- Proportioning and mixing concrete
- Pouring and finishing concrete products
- Exposing concrete aggregates

3. Safety

Be sure to wear splash-proof safety glasses at all times. Wash any cement or concrete off your skin as soon as possible and wear old clothes or coveralls.

4. Personal Activity

Before beginning work on these activities it is recommended that you scan the instructor assigned portions of the following:

Neville, A. M. (1973). Properties of concrete. New York: Wiley. ISBN # 0-470-63281-X, pp. 186-195.

White, G. R. (ed.). (1975). Basic concrete construction practices. New York: Wiley. ISBN # 0-471-67430-0, pp. 95, 253-272.

5. Other

Needed Materials:

1. Supplies

- Portland cement
- Aggregate - size to suit project
- Clean water
- Reinforcing rod/wire
- Clean sand
- Zonolite or plastic beads
- Concrete pigment

2. Equipment

- Mixing trough
- Hoe (hand and/or full size)
- Garden hose & nozzle
- Slump test cone & rod
- Concrete smoothing stone
- Pails
- Hand trowels & floats
- Edging tool
- Bristle broom

3. Handouts

A. Exposed aggregate handout

Glossary:

Admixture	Materials, other than aggregates, reinforcements, cement and water, that are added to a concrete mixture. They can change the working time or conditions, reduce thermal expansion, etc.
Aggregate	A granular material that takes up space and contributes strength to a concrete product. Typically sand, gravel, crushed stone and slag are used as concrete aggregate although ground up tires and glass have also been used.
Binders	Materials that hold other materials together, similar to glue.
Cement	Generally is Portland cement, a finely pulverized form of calcium silicate, which when mixed with water forms a binder.
Concrete	A composite material with a cement-based binder around embedded aggregate.
Entrain	To mix in. In concrete it usually refers to distributing bubbles or other material evenly throughout the product.
Plasticizers	Chemicals that reduce the amount of water required by a particular mix of concrete and increase its workability.
Reinforcing Materials	These consist of fibers, steel rods or cables inserted into the concrete mixture prior to its setting. They strengthen the product and give it special proprieties depending on how they are installed. They may be pre-tensioned in some applications.
Slump Test	A test to indicate the workability of a concrete mixture.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure
2. Complete the pre-test given by your instructor.
3. Do Activity #1 -- Concrete Mixtures & Testing
4. Do Activity # 2 -- Concrete Fabrication.
5. Review and summarize.
6. Complete post-assessment procedure.

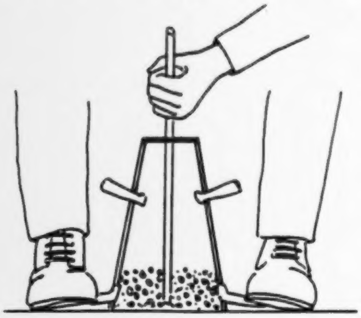
TAM #8: Concrete Processing

Activity #1 - Concrete Mixtures and Testing: Plan of Procedure

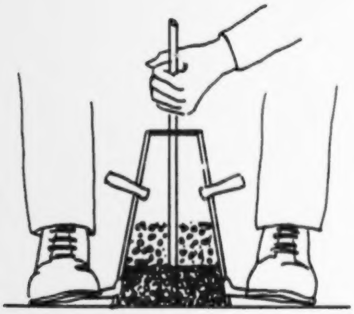
1. Prepare a pail full of each of three different concrete mixtures. For the first batch, follow the directions on the cement bag; for the second batch, change the recommended proportions by increasing the water amounts by 1/3; for the third batch, decrease the water amounts by 1/3.

2. Keep careful notes of how the mixtures appear different in workability and appearance.

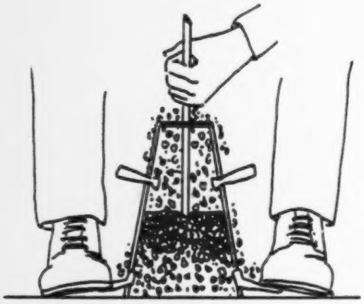
3. Perform a slump test of each mixture and record the results.



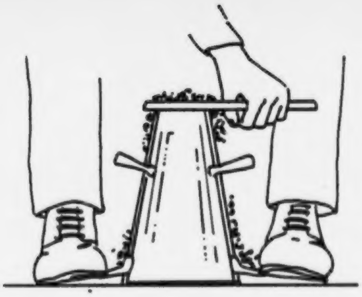
A. Stand on the cone's foot pieces to hold it down firmly during Steps A - D. Fill the cone mold 1/3 full by volume [2.5" high] with the concrete sample. Rod it using 25 strokes of a 24" long round straight steel rod, 5/8" diameter, with a hemispherical tip end. Evenly distribute strokes over the bottom layer. Slant the rod slightly to make approximately half the strokes near the perimeter). Then progress with vertical strokes spirally toward the center.



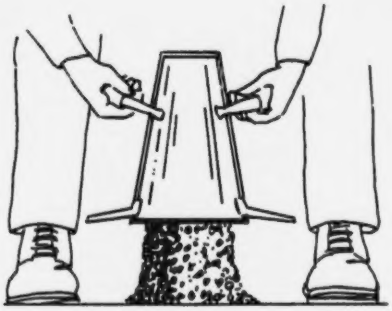
B. Fill the cone 2/3 full by volume (half the height) and again rod 25 times with rod just penetrating into, but not through, the first layer of concrete. Distribute stokes evenly as described in Step 1.



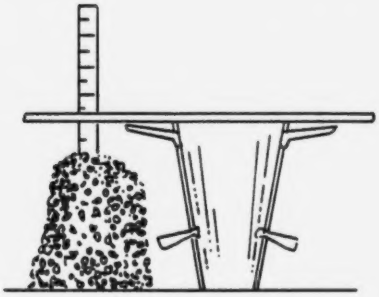
C. Fill cone to overflow and rod 25 times with the rod just penetrating into, but not through the second layer. Distribute stokes evenly.



D. Strike off excess concrete from the top of cone with the steel rod. The cone must be exactly level and full. Clean the overflow away from the base of the cone mold.



E. Immediately after completion of Step 4, raise the mold within 5 seconds. Give the cone mold a steady upward lift with no lateral or torsional motion being imparted to the concrete. The entire operation from the start of the filling through removal of the mold shall be carried out without interruption and shall be completed within an elapsed time of 2.5 minutes.

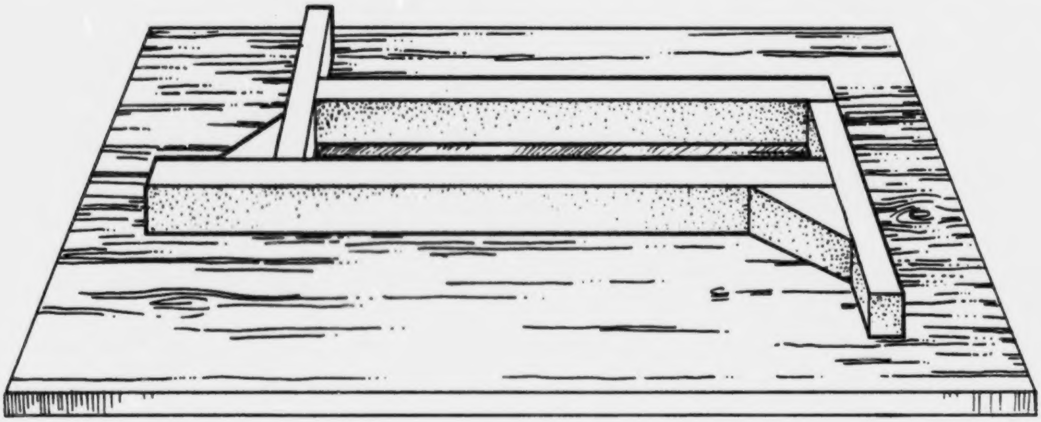


F. Place the steel rod horizontally across the inverted mold so that the rod extends over the slumped concrete. Immediately measure the distance from bottom of the steel rod to the displaced original center of the top of the specimen. This distance, to the nearest 1/4 inch is the slump of the concrete. If a decided falling away (to one side) of concrete from one side of the mass occurs, disregard the test and make a new test on another portion of the sample.

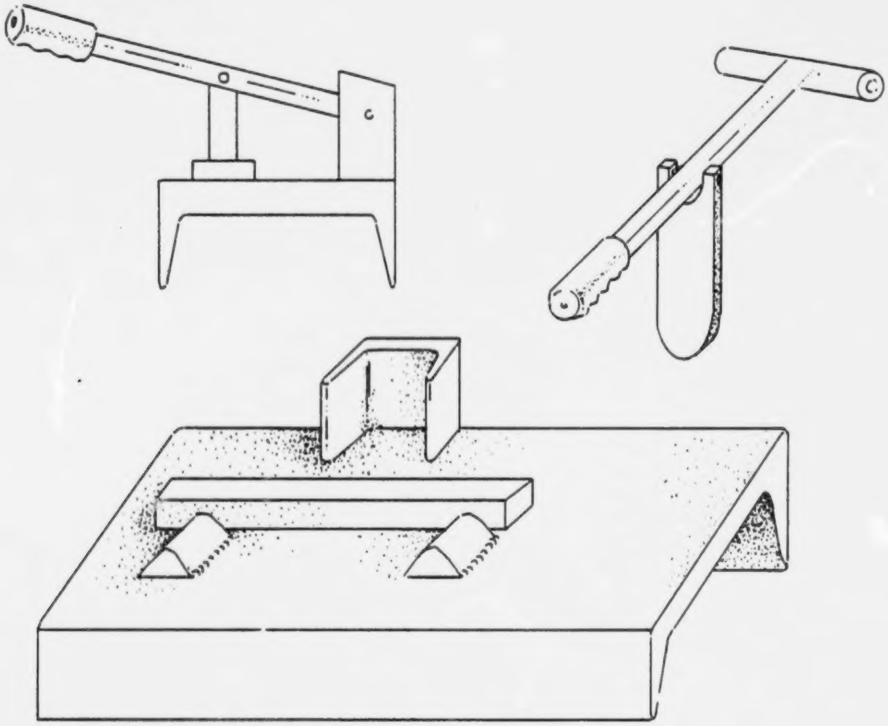
(Concrete slump test procedure per ASTM C 143-78, Courtesy of Master Builders Inc.)

4. After each slump test is recorded, divide the batch into two samples and pour each sample into a beam mold. Be certain to vibrate and/or rod each mold thoroughly in order to avoid bubbles and voids.
5. Cure one beam specimen slowly by keeping it covered with damp rags. Let the other beam set without any retardation of the setting rate by moisture. Be sure each specimen is marked to indicate type of cure and batch composition.

6. After each beam has cured for a minimum of 10 days, test each beam for strength.



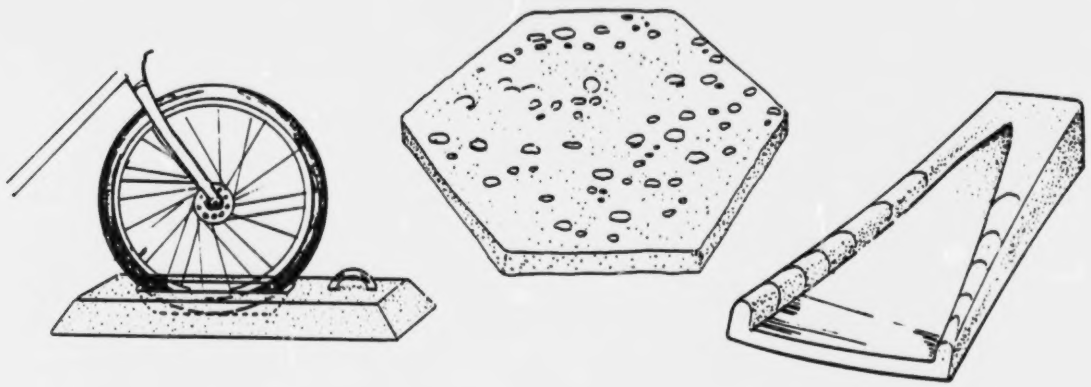
7. Analyze the results and report them to your instructor in a proper technical report form.



TAM #8: Concrete Processing

Activity #2 - Concrete Fabrication: Plan of Procedure

1. Develop a design for a concrete product. Possibilities include, but are not limited to:
   - a bicycle stand
   - a downspout splash block
   - a building footing
   - an exposed aggregate patio block
2. Design a wooden, metal or plastic mold suitable to produce your design. Be sure to make it sturdy and consider factors such as assembly, strength, draft (taper) and surface finish. Get your instructor's approval of the design and proposed materials.
3. Construct the mold using basic laboratory procedures. Be sure to employ all safety precautions.
4. Protect the mold surfaces with treatments, e.g., wax, paint, oil, etc., as appropriate to the mold materials.
5. Work out the proper ratios and amounts of cement, aggregate, water and admixtures needed.
6. Mix the ingredients properly and carefully fill the mold, being sure to tamp/rod/vibrate to avoid any air pockets.
7. Finish the exposed surfaces by troweling, brushing, marking, embedding or exposing the aggregate. For the latter, refer to the attached worksheet.
8. Cover the product with damp rags and cure appropriately.
9. Remove the product from the mold and finish it by breaking off any rough edges with a concrete smoothing stone.



TAM #8: Exposed Aggregate Procedure Handout

1. Select the aggregate to be exposed. Consider size of the particle, its appearance and its hardness and soundness. Don't use particles that break up easily.

2. Clean aggregate carefully to insure proper bonding.

3. Decide whether the aggregate is to be incorporated into the concrete mixture or if it is to be pressed into the exposed surfaces after pouring.

4. If the aggregate is to be incorporated into the mixture:
   - Keep the product moist
   - When the concrete's surface water sheen has disappeared and when it could support considerable weight without deflecting, it is ready for treatment.
   - Then brush the surface to remove the cement and expose the aggregate. If the surface is too hard, carefully pour on some water and continue the brushing. Use a nylon brush.
   - Let the surface set for some time and then repeat the brushing. Do this until enough of the aggregate is exposed. No more than 1/3 of the stone should be showing.
   - After curing as normal and removal of the mold, wash the surface with a light wash of 20% muriatic acid. Be sure to wear protective clothing and splashproof eye protection. Do this only with instructor permission and supervision.

5. If the aggregate is to be embedded into the cast product:
   - Wet the aggregate and clean it carefully.
   - Immediately after pouring the product and finishing its exposed surface with the trowel, scatter the damp aggregate evenly over the surface.
   - Embed, i.e., press down, the aggregate using a wooden float. All aggregate should be below the surface and the cement mortar should smoothly surround all particles.
   - Then brush the surface to remove the cement and expose the aggregate. If the surface is too hard, carefully pour on some water and continue the brushing. Use a nylon brush.
   - Let the surface set for some time and then repeat the brushing. Do this until enough of the aggregate is exposed, no more than 1/3 of the stone is the maximum that should be showing.
   - After curing as normal and removal of the mold, wash the surface with a light wash of 20% muriatic acid. Be sure to wear protective clothing and splashproof eye protection. Do this only with instructor permission and supervision.

TAM #8 - Summary

1. **Review & Summary Activities**

   Review your notes and test results. Summarize what you have learned about concrete and discuss this with your instructor.

2. **Review Questions – Test yourself!**

   A. What occurs when a concrete product sets?

   B. Why is the curing of concrete essential to a quality product?

   C. List the steps of procedure needed to expose aggregate.

TAM #8 - Post-assessment

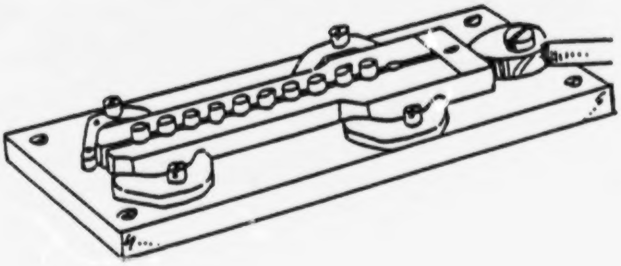
Instructions:

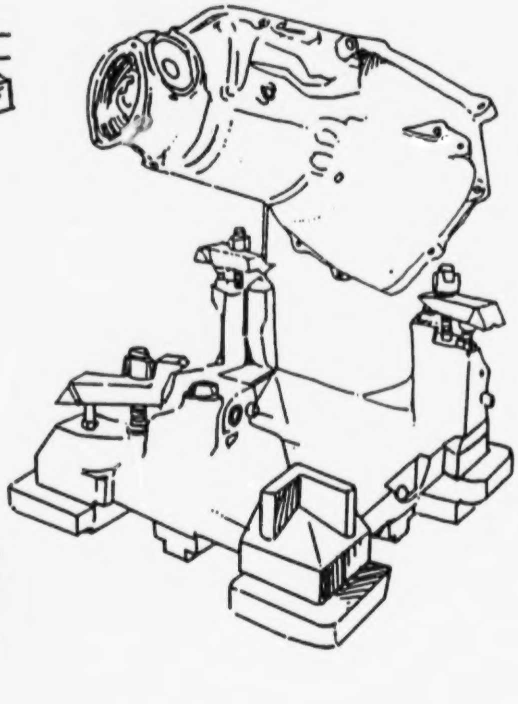
1. Complete a self-check on the concrete project you built by insuring you have performed each step on the procedure guide.
2. Have the instructor complete evaluate the product and discuss the assessment with you.
3. Complete the post-test for TAM #8.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

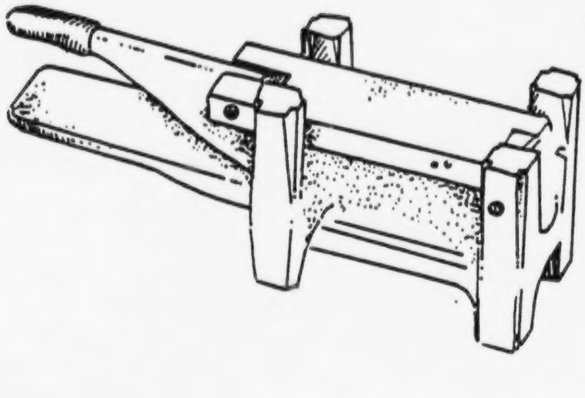
Course:	Introduction to Materials and Processing Technology

Technology Activity Module #9

Jigs and Fixtures







TAM # 9: Jigs and Fixtures

Instructor Component

Activity Objective: The main purpose for this activity is to involve students in a systematic study of jigs and fixtures, their application, design and construction. The intent is to develop capabilities that will later be used in mass production activities.

Activity Competencies: By completing this TAM, the student will be able to:

1. Demonstrate and list the safe use of tools, equipment, materials and processes involved in production technology. (5,III)
2. Identify and describe the essential features of the equipment used in manufacturing technology. (5,IV)
3. Apply hand, mechanized and automated processes in the production of a product. (5,V)
4. Devise a plan of procedures and operations for repetitive and quantity fabrication of products or components. (5,VI)
5. Employ a systematic design process to produce a product that meets the assigned design specifications. (5,VI)
6. Read technical and working drawings and prints to secure needed information. (5,VI)
7. Solve simulated industrial design or planning problems in the production of a product. (5,VI)

Module Instructions

Introduction:

The success of any production system depends considerably on quality jigs and fixtures. They are an important aspect of any manufacturing processes' consistency and quality control, not to mention speed/efficiency. When applied properly, jigs and fixtures improve productivity and generally increase the overall product quality. This activity should help in expanding student awareness of these essential manufacturing components and it will bring to their attention the key factors involved in the production, design and use of jigs and fixtures. The student activities include safety instructions, demonstrations, jig/fixture design and construction, pre-test and post-test.

Safety Considerations:

The student should be prepared to employ proper laboratory safety procedures associated with metal and wood working. The instructor must make sure that all jigs and fixtures used in association with power tools do not contribute to increasing the risk of their use. Similarly these devices must be built sturdily enough to resist machine loads, torque and kickbacks in the event of a problem.

Needed Materials:

1. **Supplies**

- Steel, strap iron
- Tool steel
- Aluminum plate
- Screws
- Bolts and nuts

2. **Equipment**

- Metal working equipment
- Machine woodworking equipment
- Arc welders
- Precision measurement & inspection equipment

3. **Handouts**

A. Student Component of TAM #9

4. **Instructional Resources**

A. Film (Review the products from the National Association of Machine Tool Builders and from the Society of Manufacturing Engineers)

B. Books and Articles

Select publications of the National Tool and Die Association that are appropriate to your assignment.

Boyes, W. E. (1979). Jigs and fixtures. Dearborn, MI: Society of Manufacturing Engineers. ISBN # 0-87263-051-X, pp. 1-100.

Henriksen, E. K. (1973). Jigs and fixture design manual. NY: Industrial Press. ISBN # 0-8311-1098-8, pp. 1-92.

More, H. D. & Kibbey, D. R. (1965). Manufacturing materials and processes. IL: Irwin. ISBN # 65-12419, pp. 460-478.

Walker, W. F. (1969). Beginners guide to jig and tool design. New York: Hart. pp 39-169.

Wright, C. (May 1987). Making jigs and fixtures teaching tools. Industrial Education. pp. 39-43.

C. A guest lecturer from a local machine shop, factory or SME chapter. Invite him/her to bring sample jigs and fixtures (or pictures).

Management/Logistics:

1. **Related TAMS:** TAM 10, Mass Production

2. **Evaluation/Grading**

   Assess students' performance based on how well they apply the jig/fixture design process and on their workmanship.

3. **Suggested Schedule/Time**

   A period of two to three weeks is recommended

Key Instructional Suggestions:

1. **Safety**

   Stress the great amount of force that must be controlled and/or absorbed by a jig/fixture. Remind students also of the need for continual vigilance with respect to safe work practices.

2. **Motivation**

   Point out how with proper jigs/fixtures, productivity and quality can both go up significantly. Translate this into increased profitability potential for a student-operated enterprise.

3. **Prerequisite Information**

   Some basic familiarity with the key manufacturing processes, as well as a knowledge of what is to be produced. Sufficient skill with laboratory procedures is needed to enable jig/fixture construction.

4. **Demonstrations**

   - The jig/fixture design process -- work through an example
   - Show and tell about various jigs/fixtures built by previous classes and/or used by industry

5. **Reinforcement**

   Introduce the concept of statistical deviation from the norm. Show how the normal-curve applies to production processes. Interact with the math teacher to highlight concepts that are being taught in that curriculum.

6. Attitudes

Stress the notion that "little things count," even thousandths of inches!

7. Remediation/Enrichment

A. Remediation: The activity in this TAM will require students to work in teams. Be sure to arrange these teams so that slower students are not concentrated in any one team.

B. Enrichment: Have faster students make a scrapbook of jig and fixture designs from trade magazines, reference books and from pictures/sketches made on field trips to industry. Have students attempt to develop a classification system to group jigs and fixtures.

8. Summary & Review

- The jig/fixture design process
- Relationships of production quantities to jig/fixture investment
- Typology of jigs/fixtures

9. Review Questions & Answers

A. What are the main reasons for using a jig/fixture? *To increase control over production variables, increase production rate*

B. How are jigs and fixtures different? *The former guides a tool into place while the latter holds work in place*

C. When would one not want to use a jig/fixture? *For work that is to be custom crafted and where great uniformity of parts would take away from the desired effect.*

D. What are the main steps in developing a jig/fixture?

1. *Locating the work piece and determining the degrees of freedom*
2. *Applying clamping elements*
3. *Providing support to absorb/counteract all applied loads.*
4. *Provide guidance for the cutter. Identifying how a cutter will be engaged with the part.*
5. *Completing the body/frame of the jig/fixture to supporting all the components and the part.*

Date: ________ **Class:** ____________________ **Name:** _________________

TAM #9 - Pre-test (Jigs & Fixtures)

Instructions: Read each item carefully and choose the best answer

1. A jig is a:
    - a. Device for holding work.
    - b. Tool for guiding and supporting tools.
    - c. Measuring device.
    - d. All of the above.
2. A fixture is a:
    - a. Tool for guiding & supporting tools.
    - b. Device for holding work.
    - c. Method of holding a gauge.
    - d. All of the above.
3. Jigs and fixtures are:
    - a. Special tools used only for boring and milling machine shop operations.
    - b. Generally designed and built specifically for making one part only and for only one operation on that part.
    - c. Quite frequently interchanged.
    - d. All of the above
4. Which key principle(s) applies to clamping of work?
    - a. Clamping stresses should be kept low.
    - b. Clamping forces should direct the work against the points of work support.
    - c. As many operations as practicable should be done with each single clamping of work.
    - d. All of the above.
    - e. None of the above.

Instructions: Fill in the blank spaces provided with an appropriate short answer/word from the list provided.

5. Locating a work piece in a jig or fixture requires adherence to the: ____________.
6. When jigs or fixtures are used in connection with chip-making operations, ______________ must be made for the ______________ of ______________.

Clamps   Tools   3-2-1 Principle   Laws of gravity
clearance/relief   escape/removal   stress/strain equation   chips

(Henriksen, 1973)

Date: ________ **Class:** ________________ **Name:** ______________

TAM #9 - Post-test (Jigs & Fixtures)

Instructions: Fill in the blank spaces provided with the appropriate word.

1. ____________ and ____________ of operation are factors which are very important to jigs and yet which are often overlooked when designing special tooling.

2. There are many ways by which jigs/fixtures may be made easier and more efficient to use. One of these ways is: ______________ .

3. Jigs are available in many different types. Name any five types:

   A.______________
   B.______________
   C.______________
   D.______________
   E.______________

Instructions: Choose the best answer.

4. Because of the accuracy, durability and sturdiness which must be built into jigs/fixtures, they are:

   a. Difficult to construct
   b. Quick to construct
   c. Relatively costly
   d. All of the above

5. The primary factors involved in justifying special tooling are:

   a. The cost
   b. The interest
   c. Savings in production labor costs
   d. The number of pieces to be produced
   e. All of the above
   f. None of the above

(Boyes, 1979)

TAM #9 - Test Keys

TAM #9 - Pre-test Answers

1. b 2. b 3. b 4. d

5. Locating a work piece in a jig or fixture requires adherence to the *321 principle* .

6. When jigs or fixtures are used in connection with chip-making operations, *clearance/relief* must be made for the *escape/removal* of *chips* .

TAM #9 - Post-test Answers

1. *Rapidity* and *ease* of operation of jigs and fixtures are very important factors which are often overlooked when designing special tooling.

2. There are many ways by which jigs/fixtures may be made easier and efficient to use. One of these ways is: *automatic clamping*. (Note, accept other correct answers also).

3. Jigs are available in many different types. Name any five types:

   A. *Open plate jig*
   B. *Ring*
   C. *Box*
   D. *Universal*
   E. *Vise*

4. a, c

5. c

TAM # 9: Jigs and Fixtures

Student Component

Introduction:

The significance of jigs and fixtures on almost all production process cannot be overemphasized. Good jigs and fixtures improve accuracy, repeatability, durability and safety while reducing operating costs through increased speed and efficiency. Badly designed jigs and fixtures create undesirable consequences such as injury, poor quality, loss of time and money, etc. In this module you will learn designing and constructing processes. This activity will guide you, expand and improve your imagination and help you become aware of some of the questions involved in the design and construction of jigs and fixtures. (adapted from Boyes, 1979)

Competencies: Following the completion of this TAM, you will be able to:

1. Demonstrate and list the safe use of tools, equipment, materials and processes involved in production technology. (5,III)
2. Identify and describe the essential features of the equipment used in manufacturing technology. (5,IV)
3. Apply hand, mechanized and automated processes in the production of a product. (5,V)
4. Devise a plan of procedures and operations for repetitive and quantity fabrication of products or components. (5,VI)
5. Employ a systematic design process to produce a product that meets the assigned design specifications. (5,VI)
6. Read technical and working drawings and prints to secure needed information. (5,VI)
7. Solve simulated industrial design or planning problems in the production of a product. (5,VI)

Module Overview:

This module has one primary activity, namely to design and make a jig and/or fixture. The class will be divided into several groups and each will be assigned a specific piece of tooling to design and produce.

Key Information:

1. Class Presentations

A. Reasons for using jigs/fixtures
  i. Increase production (quantity)
  ii. Increase quality
  iii. Simplify complicated work
  iv. Skill transfer device
B. Types of jigs and fixtures
C. Characteristics of good jigs and fixtures
D. Jig and fixture design process

2. Demonstrations

Watch the instructor's case study of jig design as used in previous projects

3. Safety

When building the jig/fixture remember to follow standard laboratory work procedures. If there is something special required by your jig/fixture get your instructor's advice first.

4. Personal Activity

Before beginning work on these activities it is recommended that you read/scan:

Boyes, W. E. (1979). Jigs and fixtures. Dearborn, MI: Society of Manufacturing Engineers. ISBN # 0-87263-051-X, pp. 1-100.

More, H. D. & Kibbey, D. R. (1965). Manufacturing materials and processes. Chicago, IL: Irwin. ISBN # 65-12419, pp. 460-478.

5. Other

Glossary:

Assembling	The process of combining components.
Clamping	Holding parts so that they can be safely worked on.
Ejector	A device that pushes a part out of a fixture.
Fixture	A special device for holding work when manufacturing.
Jig	A special device for positively guiding and supporting tools.
Loading	The forces generated by clamping and by machine tool action on the part. This term is also used to refer to the inserting of parts into a jig/fixture.
Locating	The positioning of a part or tool by action of the fixture or jig.
Support	The force of a jig/fixture on the work in such a way that the work piece does not deflect/bend as a result of cutting and clamping forces.
Tooling	A general name often used to refer to jigs, fixtures and the actual tools doing the work.
Unloading	The removal of parts from a jig or fixture.

Needed Materials:

1. **Supplies**

   - Steel, strap iron
   - Tool steel
   - Aluminum plate
   - Screws
   - Bolts and nuts

2. **Equipment**

   - Metal working equipment
   - Machine woodworking equipment
   - Arc welders
   - Precision measurement & inspection equipment

3. **Handouts**

   A. Student Component of TAM #9

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.

2. Complete the pre-test given by your instructor.

3. Do Activity #1 - Designing Jigs and Fixtures.

4. Do Activity # 2 - Comparing Jigs and Fixtures.

5. Review and summarize.

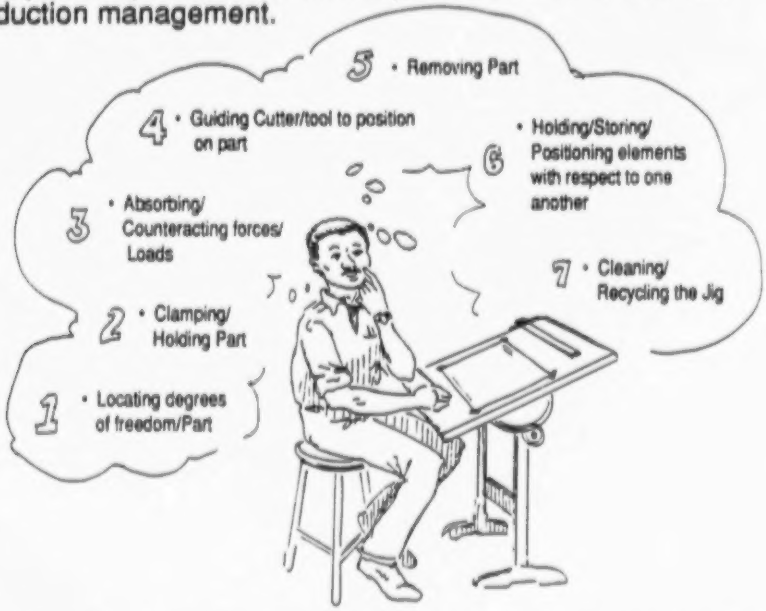
6. Complete post-assessment procedure.

TAM # 9: Jigs and Fixtures

Activity #1 - Designing Jigs & Fixtures: Plan of Procedure

1. Form your team and assign specific roles to each member. These could include: drafter, researcher, engineer, production liaison and the like.

2. Secure and analyze all specifications for the part to be made. Confirm these with production management.


5 • Removing Part
4 • Guiding Cutter/tool to position on part
6 • Holding/Storing/ Positioning elements with respect to one another
3 • Absorbing/ Counteracting forces/ Loads
7 • Cleaning/ Recycling the Jig
2 • Clamping/ Holding Part
1 • Locating degrees of freedom/Part

3. Analyze the possibilities by first considering operator-related concerns such as those identified by Henriksen (1973, p. 9):

   A. Speed Considerations:

      i. Lifting, moving, and lowering fixture weight & hoisting equipment
      ii. Loading and unloading part into and out of fixture
      iii. Clamping of part

   B. Safety of Work:

      i. Locating part correctly in fixture (fool-proofing concept)
      ii. Adjustment of cutter

   C. Operator Consideration:

      i. Fatigue
      ii. Operational safety (accident-proof concept)

   D. Miscellaneous:

      i Supply and return of cutting fluid
      ii. Chip cleaning and disposal

4. Now begin the Fixture Planning process. In doing this you will need to analyze and establish:

   A. Details of part description
   B. Classification of operations
   C. Classification of machines and other equipment
   D. Manipulation and operator criteria
   E. General considerations

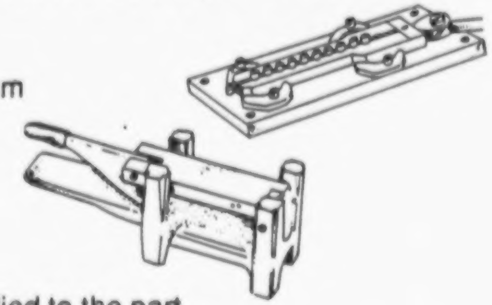
5. While designing the jig/fixture, the Henriksen's (1973) general considerations in fixture design should be kept in mind. To do this, think of how you will accomplish each of the following in the jig/fixture you are building:

   A. Loading and unloading of the part
   B. Locating parts in fixture to permit easy access of cutting tools
   C. Clamping of the part
   D. Support of the part
   E. Positioning of the cutting tool relative to the part in the fixture
   F. Supplying and collecting of the coolant
   G. Removal of chips

6. Be careful to positively locate the part and to clearly specify the degrees of freedom for it.

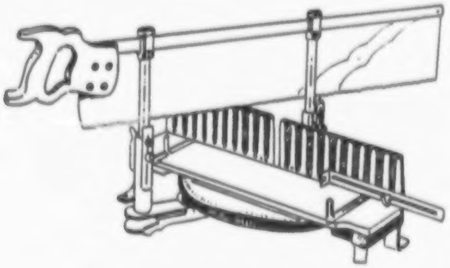
7. Incorporate appropriate clamping elements to hold the part. These can include:

   A. Screws
   B. Wedges
   C. Cams
   D. Toggles
   E. Air pressure/Vacuum
   F. Magnetism



8. Provide support to absorb all loads applied to the part.

9. Provide guidance for the cutter. Specify how the tool will be engaged with the part.

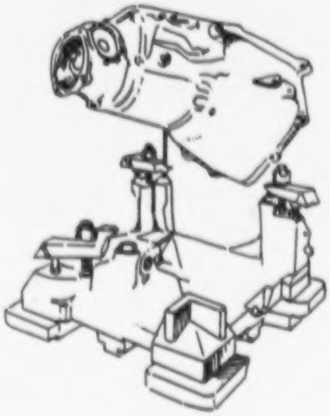


10. Complete the body or structure for supporting the part and jig/fixture components.

11. Locate the part with appropriate components. To do this:
    A. Identify appropriate surfaces (i.e. If a part is positioned against a defined feature, then when a clamp is applied, the parts movement will be restricted in that place of motion).
    B. Consider the appropriateness of nesting (i.e. Restriction of part movement along two or more surfaces so that motion is prevented in the two opposite direction).

12. Plan how to load and unload the part from the jig/fixture

13. Consider other requirements
    A. Symmetry considerations
    B. Foolproofing
    C. Burred parts
    D. Chip problems



14. Throughout the design process the engineer must keep in mind:
    A. Dimensions, material and weight of the part
    B. Existing surface finish & accuracy of its surfaces
    C. The accuracy in operations to be performed
    D. The quantity to be manufactured
    E. The probability for multiple machining
    F. Safety for the operator, equipment & part

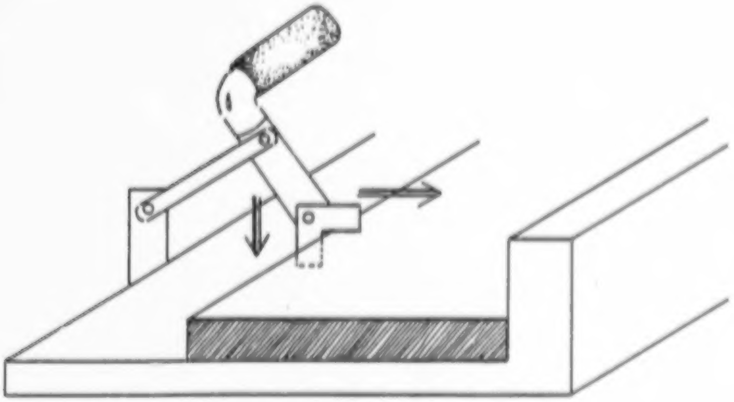
TAM # 9: Jigs and Fixtures

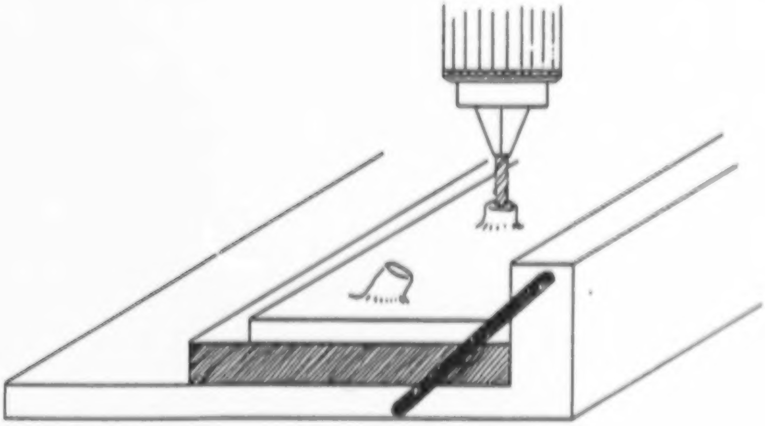
Activity #2 - Analyzing Jig & Fixture Design: Plan of Procedure

1. Pair up with another of the class teams and discuss each team's jig/fixture. Consider each of the design considerations. Have the other team suggest ways by which that criterion could be met better just as you are working on improving their jig/fixture.

2. Keep a record of all improvements and suggestions and incorporate the best in your prototype jig/fixture design.

3. Secure instructor approval for the final design and then make the jig/fixture using appropriate laboratory procedures.





Activity Module #9 - Summary

TAM #9 - Summary

1. Review & Summary Activities

Jigs and fixtures are commercially available components. The origin of jigs and fixtures can be traced back to the Swiss watch and clock industries. After these industries proved the precision and usefulness of jigs/fixtures, many other industries around the world began using them extensively -- and with remarkable results!

The major use for jigs and fixtures is obviously in mass production. However, their advantages are so great that they have found their way into custom and job-shop production of parts. Jigs/fixtures have become so important over the past years that, now, they are used in many unique applications world over. (Henriksen, 1973)

Complete the following summary activities:

A. List the key steps involved in jig/fixture design

B. Identify six major considerations important to jig/fixture design

2. Review Questions -- Test yourself!

A. What occurs when a part is clamped in a jig?

B. Why is chip clearance important to the design of machining jigs/fixtures?

TAM #9 - Post-assessment

Instructions:

1. Complete a self check on the jig/fixture you designed by seeing if you can explain, in your own words, how you analyzed and applied each key consideration in your jig/fixture.
2. Have the instructor complete an evaluation of your jig/fixture and discuss discrepancies between their and your assessments.
3. Complete the Post-test for TAM #9
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #10

Automated Manufacturing

TAM #10: Automated Manufacturing

Instructor Component

Activity Objective: The purpose of this activity is to develop student understanding of the concepts involved in automation. Students will learn how the various aspects of an automated plant must be coordinated systematically.

Activity Competencies: By completing this TAM, the student will be able to:

1. Identify and describe the essential features of the equipment used in manufacturing technology. (5,III).
2. Apply hand, mechanized and automated processes in the production of a product by setting up a model production facility using simulated machines. [5,V]
3. Explain the industrial processes employed to separate, combine, condition, form and fabricate materials into functional items. [5,IV]
4. Devise a plan of procedure and operations for repetitive and quantity fabrication of products or components. [5,V]
5. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,VI]
6. Read technical and working drawings and prints to secure needed information. [5,VI]
7. Solve simulated industrial design or planning problems in the production of a product by explaining how industrial models and simulations correspond to real industrial functions. [5,VI]
8. Demonstrate the safe use of tools, equipment, materials and processes that are related to production technology by operating an industrial simulation model. [5,III]
9. Discuss production technology breakthroughs and future trends in industry. [5,XIII]

Module Instructions

Introduction:

This activity is designed to familiarize students with automated manufacturing and to highlight how automation has affected manufacturing and the future. Students will apply problem-solving techniques to design and sketch a solution to a given automation problem. Then they will build a working model. It is highly recommended that this program be integrated with a series of classroom presentations about automated production. Activities in this module include: pre- and post-tests, design of an automated production facility, set-up of an automated plant and/or simulation of such a plant.

The Fischertechnik or LEGO Technic models described in this TAM are but one means by which manufacturing automation can be learned. Certainly there are other brands of equipment that may be used as well. The important point is that the industrial models are made to operate like a real computer integrated manufacturing system (CIM) and that students have the experience of blending electronics, logic and mechanical systems in support of a manufacturing goal.

Safety Considerations:

Students using the Fischertechnik or LEGO Technic materials need to be careful when working with DC power supplies used to drive motors. Students should check with the instructor for approval before turning on any power.

Needed Materials:

1. **Supplies**

   Computer disks, blank, to suit available computer

2. **Equipment**

   - Ground fault circuit interrupters (GFCI)
   - Starter Fischertechnik or LEGO Technic set
   - Motor and gear Fischertechnik or LEGO Technic set c/w
     - pneumatic systems
     - robot models
     - computer interface
   - DC power supply
   - Machine Tool (advanced) Fischertechnik or LEGO Technic set
   - Additional sets such as:
     - High level storage warehouse
     - Three axis control model
     - Flexible processing line
     - Conveyor model
     - Lifting table model
     - Transporting and sorting model

   Note: Although reference is made to Fischertechnik and LEGO Technic throughout, most of the TAM's goals can also be accomplished with other building systems or even "home-brew" ones assembled from surplus hardware.

3. **Handouts**

   A. Student Component of TAM #10
   B. Problem-solving Process Handout

4. **Instructional Resources**

   A. Film, "Race Against Time," see also C below.

   B. Books and Articles

      Bame, A. & Cummings, P. (1988). Exploring technology. Worcester, MA: Davis. ISBN # 0-87192-196-0, pp. 275-323.

      Fales, J.; Kutemeyer, V. , & Brusic, S. (1988). Technology, today and tomorrow. Bloomington. IL: Glencoe. ISBN # 0-02-677020-2, pp. 167-169.

      Potter, T. & Guild, I. (1983). Robotics. Usborne New Technology Series. London, UK: Usborne. pp 18-19.

      Schmitt N. M. & Farwell, R. F. (1984). Understanding automation systems. Dallas, TX: Texas Instruments. ISBN # 0-672-27014-5, pp. 1-12.

      Todd, R.; McCrory, D., & Todd, K. (1985). Understanding and using technology. Worcester, MA: Davis. ISBN # 0-87192-165-0, pp. 280.

   C. A guest lecturer who will deal with an overview of manufacturing automation. If this is not possible, contact the National Bureau of Standards in Gaithersburg, Maryland for a list of videotapes on the topics.

   D. Computer-based manufacturing simulation programs, where the entire simulation exists only on the cathode ray tube, represent a natural adjunct, or possibly even an alternative, to the model-based simulation described in this TAM.

Management/Logistics:

1. **Related TAMS**

   TAM #2, Problem Solving; TAM #12, Mass Production and TAM #11, Robotics.

2. **Evaluation/Grading**

   A. Pre-test and post-test

   B. 50% laboratory work and 50% written examination

3. **Suggested Schedule/Time**

   One to two weeks if the building kits are available and if just a quick overview is desired. Much more time is needed for an indepth experience of if students have to work with surplus components.

Key Instructional Suggestions:

1. **Safety**

   Be sure to double check that all safety procedures pertaining to electricity are understood and are observed properly.

2. **Motivation**

   Field trips to local plants and or trade expositions, with videotapes being a distant third, will be helpful in exciting students who have not actually seen automation in action.

3. **Prerequisite Information**

   Some basic knowledge of factory components and mechanical systems such as gears, cams, jigs and fixtures would be helpful.

4. **Demonstrations**

   - Power supplies and the connection of electronic components (meters, etc.) in the Fischertechnik or LEGO Technic series

   - Interfacing the models to the computer

5. **Reinforcement**

   To reinforce related content, the ITE instructor should contact the mathematics instructors and discuss how to jointly deal with the logic involved in interfacing.

6. **Attitudes**

   Emphasize to the students the importance of not getting discouraged if they encounter problems during the process -- automation is a complicated process!

7. **Remediation/Enrichment**

   A. Remediation: Review the objectives, re-start from where the student got lost, team the student with more resourceful students.

   B. Enrichment: Have advanced students guide slower students. Also students who finish early may add to or improve the automation model. Research projects on automation related topics are exciting for advanced students. Try to reinforce their writing skills with such an assignment. Have the best students work with industry to solve a real production problem.

8. **Summary & Review**
   - Controlling of automation
   - Automated assembly line
   - Tooling
   - Manufacturing process

9. **Review Questions & Answers** *(Answers are in italics)*

   A. For what two types of jobs are robots normally used?
      1. *Hazardous jobs*
      2. *Repetitive jobs*

   B. How do robots increase productivity?
      1. *Robot Speed*
      2. *Flexible automation*
      3. *Accuracy and repeatability*

   C. What are the major parts of a robot?
      1. *The manipulator/gripper*
      2. *The power supply*
      3. *The controller*

   D. What is the work envelope? *The total area/space that the end of the robot's arm can reach.*

   E. How are robots and production machines linked in automated manufacturing? *By central and networked computers, by a materials/product handling system, by ongoing real-time quality control.*

TAM #10 - Test Keys

TAM #10 - Pre-test Answers

1. d 2. d 3. d 4. b 5. d

TAM #10 - Post-test Answers

1. d 2. b 3. d 4. a 5. d

Date: ________ **Class:** ________________ **Name:** ________________

TAM #10 - Pre-test (Automated Manufacturing)

Instructions: Select the best response to each question.

1. A conventional manufacturing system can be: [M&P,T#10,5,III]

   a. an automated assembly line.
   b. very difficult to change when new products are introduced.
   c. expensive to alter.
   d. all of the above.

2. Automation typically: [M&P,T#10,5,III]

   a. displaces some workers
   b. increases productivity or profit
   c. gives a competitive advantage
   d. all of the above

3. Compared to humans, machines: [M&P,T#10,5,III]

   a. can work in harsher environments.
   b. can make more complex decisions based on unexpected circumstances.
   c. make fewer errors.
   d. A. and C

4. Automation typically causes: [M&P,T#10,5,III]

   a. a net loss of jobs.
   b. a net increase of jobs.
   c. no change in jobs.
   d. none of the above

5. Automation involves: [M&P,T#10,5,III]

   a. workers controlling machines.
   b. assisting or replacing humans.
   c. increased productivity.
   d. all of the above

(Adapted from Schmitt & Farwell, 1984)

Date: ________ **Class:** ________________ **Name:** ________________

TAM #10 - Post-test (Automated Manufacturing)

Instructions: Circle the correct answer.

1. The use of modern control technology in automation systems: [M&P,T#10,5,IV]
   a. increases yield.
   b. reduces costs.
   c. improves readability.
   d. all of the above

2. The heart of automation technology consists of: [M&P,T#10,5,IV]
   a. robots.
   b. computers.
   c. sensors.
   d. control networks.

3. The electronic component that has been the key to recent developments in automation is the: [M&P,T#10,5,III]
   a. improved vacuum tube.
   b. integrated circuit.
   c. transistor.
   d. diode.

4. Programmable devices are advantageous because: [M&P,T#10,5,III]
   a. changes can be made quickly.
   b. separate microprocessors are unnecessary.
   c. only high skilled professionals can make changes.
   d. none of the above

5. Which of the following may be classified as an automation system? [M&P,T#10,5,III]
   a. numerically controlled machine tools.
   b. automated warehouse.
   c. robots.
   d. all of the above

(Adapted from Schmitt, & Farwell, 1984)

TAM #10: Automated Manufacturing

Student Component

Introduction:

Automated production is one of the most spectacular developments in the area of electronics and modern technology. The Fischertechnik or LEGO Technic models are one way to model computer-integrated manufacturing systems. The system is modular and intermixes to make a large variety of very representative simulations possible.

In this TAM, you will use the problem-solving method to design and sketch a solution, and assemble and operate a computer-integrated manufacturing plant.

Competencies: Following the completion of this TAM, you will be able to:

1. Identify and describe the essential features of the equipment used in manufacturing technology. [5,III]
2. Apply hand, mechanized and automated processes in the production of a product by setting up a model production facility using simulated machines. [5,V]
3. Explain the industrial processes employed to separate, combine, condition, form and fabricate materials into functional items. [5,IV]
4. Devise a plan of procedure and operations for repetitive and quantity fabrication of products or components. [5,V]
5. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,VI]
6. Read technical and working drawings and prints to secure needed information. [5,VI]
7. Solve simulated industrial design or planning problems in the production of a product by explaining how industrial models and simulations correspond to real industrial functions. [5,VI]
8. Demonstrate the safe use of tools, equipment, materials and processes that are related to production technology by operating an industrial simulation model. [5,III]
9. Discuss production technology breakthroughs and future trends in industry. [5,XIII]

Module Overview:

This module contains two activities. They are designed to give you a chance to explore automation using working models developed by you with the Fischertechnik or LEGO Technic equipment. After you complete these TAM activities, you will be able to identify examples of automation around you.

1. Planning a simulated automated production plant
2. Constructing and operating an automated production plant

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity # 1 -- Planning a simulated automated production plant.
4. Do Activity # 2 -- Constructing and operating an automated production plant.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. **Class Presentations**
    - Problem-solving method (review)
    - Production plant layout
2. **Demonstrations**
    - Building with Fischertechnik or LEGO Technic
    - Simulating production
    - The process of automation
3. **Safety**

    Possible concerns involve the electricity associated with the control and power systems. Use battery and other low voltage components rather than high voltage/current devices..

4. Personal Activity

Before beginning work on these activities it is recommended that you read the assigned pages in the following:

________. (quarterly). Fischertechnik newsletter. Fischer America Inc.,1904 Oostburg Court, Modesto, CA 95356, (209) 575 -3445

Bame, A. & Cummings, P. (1988). Exploring technology. Worcester, MA: Davis. ISBN # 0-87192-196-0, pp. 275-323.

Fales, J.; Kutemeyer, V. & Brusic, S. (1988). Technology, today and tomorrow. Bloomington. IL: Glencoe. ISBN # 0-02-67020-2, pp. 167-169.

Potter, T. & Guild, I. (1983). Robotics. Usborne New Technology Series. London, UK: Usborne Publishing. pp. 18-19.

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Todd, R.; McCrory, D. & Todd, K. (1985). Understanding and using technology. Worcester, MA: Davis Publications. ISBN # 0-87192-165-0, pp. 280.

5. Other

View the video tape titled "Race Against Time" or other program assigned by the instructor.

Glossary:

Automation	The operation of machines without direct human control; machines are controlling machines.
Cam	A moving device with one or more lobes (projections) which, as the device moves, operates levers or switches that cause mechanical or electrical functions.
Computer	A programmable machine capable of accepting, processing, storing and outputting data.
Conveyor	A mechanical apparatus for moving products or materials from place to place.
Cybernetics	The intelligent control of machines by computers.
Industrial Robot	A programmable, multi-functional manipulator designed to move material parts, tools or specialized devices through variable programmed motions for the performances of a variety of tasks.
Interface	The bridge between two parts of a system. For example, an optical sensor interfaces to a controlling computer to tell it whether or not there is a part waiting to be picked up.
Ladder Logic	A graphic way of depicting the yes/no decisions involved in controlling automated industrial equipment.
Pneumatics	Involves the transmission of power transmitted through gas (usually air) filled tubes and components such as cylinders.
Simulation	The representation of something by means of a game or model, often on a computer.
Transfer Line	A manufacturing system in which individual stations are indirectly connected together by means of a conveyor system.

Needed Materials:

1. **Supplies**

   Computer disks, blank, to suit available computer

2. **Equipment**

   - Ground fault circuit interrupters (GFCI)
   - Starter Fischertechnik or LEGO Technic set
   - Motor and gear Fischertechnik or LEGO Technic set c/w
     - pneumatic systems
     - robot models
     - computer interface
   - DC power supply
   - Machine Tool (advanced) Fischertechnik or LEGO Technic set
   - Additional sets such as:
     - High level storage warehouse
     - Three axis control model
     - Flexible processing line
     - Conveyor model
     - Lifting table model
     - Transporting and sorting model

3. **Handouts**

   A. Problem-solving Process Handout

TAM #10: The Problem-solving Process Handout

A. Identify problem
   - Analyze problem
   - Analyze the problem's context
   - Define & clarify the problem

B. Establish solution criteria
   - Identify appropriate criteria
   - Identify constraints and limitations
   - Weight criteria according to the nature of the problem
   - Develop a design brief

C. Assemble pertinent information
   - Search for information
   - Analyze information
   - Synthesize appropriate information

D. Formulate alternative solutions
   - Brainstorming
   - Remove barriers to creative juices

E. Evaluate alternatives
   - Apply solution criteria
   - Select optimum solution

F. Implement prototype solution
   - Develop prototype solution
   - Produce drawings
   - Theoretically test
   - Plan implementation of solution
   - Implement prototype solution
   - Evaluate prototype solution in operation

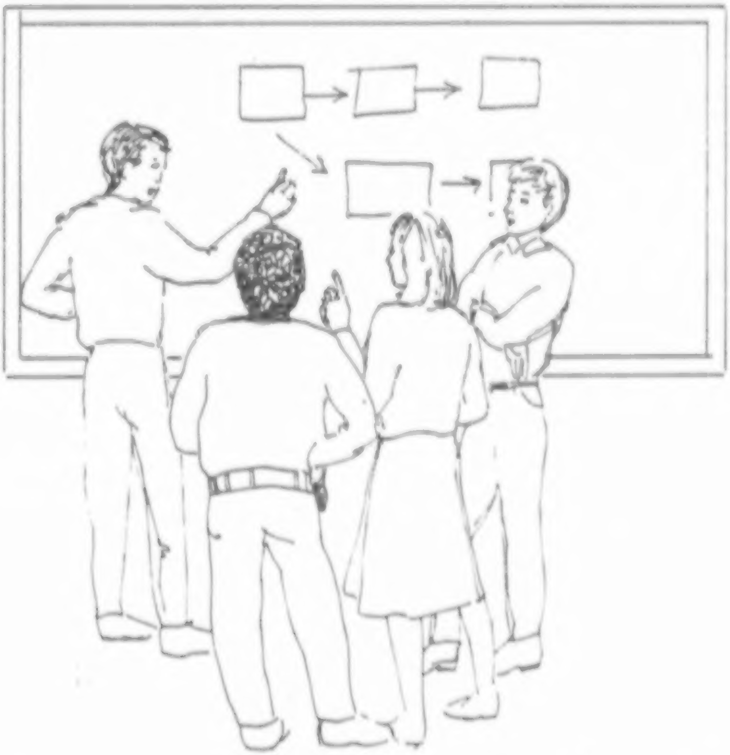
G. Refine solution
   - Communicate the solution
   - Refine the prototype solution
   - Implement the refined solution
   - Monitor the solution on an appropriate basis

TAM #10: Automated Manufacturing

Activity #1 - Planning a Simulated Production Plant: Plan of Procedure

To carry out these activities you need a variety of packages of Fischertechnik or LEGO Technic kits or equivalent modeling sets. Your instructor will assign you to design teams. Each team is required to implement the procedures, as listed below, according to their production design assignment.

1. Document your production plant:
   - General sketch
   - Identify each component/machine
   - Describe specific function
   - Detail needed tooling, etc.
2. Make a decision about the type of production best suited to the product:
   - Fixed position of groups
   - Process/product company layout
   - General considerations
3. Communicate among groups involved in planning the plant by:
   - Oral assignment
   - Presentation
   - Formal memos

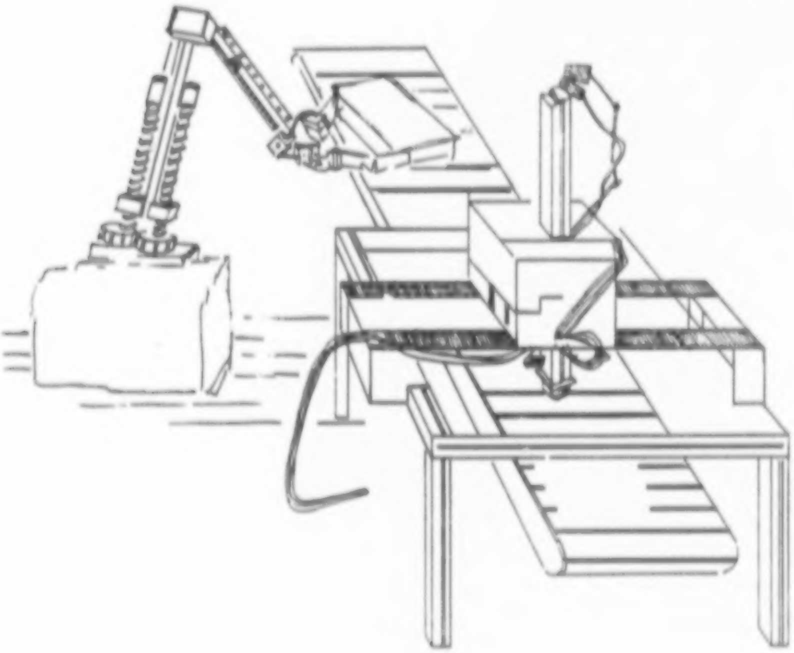


4. Flowchart the production system and establish key specifications:
   - Classify the operations
   - Classify the machinery and equipment
   - Physical arrangement of equipment within assigned area
   - Run the system

5. Plan the links between the modules by considering:
   - Space required between one module and the others
   - Material flow
   - Distance to transport parts/products
   - Others

6. Test the system on paper:
   - Accuracy in operations
   - Quality of the product and how to manufacture it
   - Safety of the machinery and equipment
   - Test the plan
   - Test the product

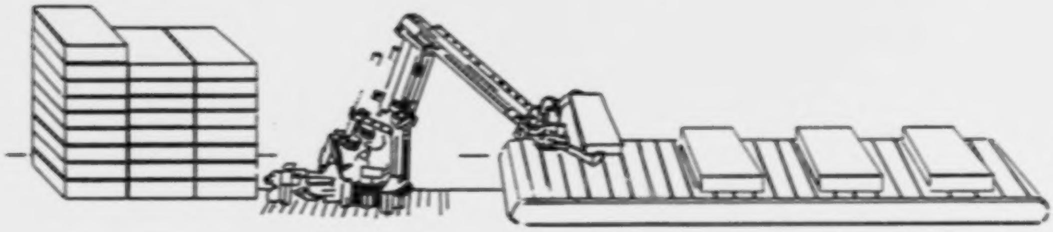
7. Check with your instructor for final approval.

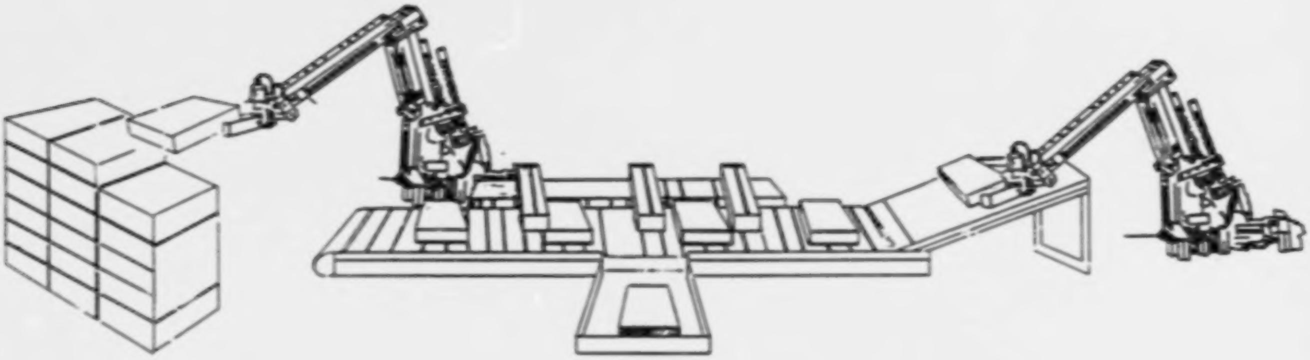


TAM #10: Automated Manufacturing

Activity #2 - Assembling and Operating a Production Plant: Plan of Procedure

1. Obtain reference sheets from your instructor and review the documentation produced by the teams who developed this TAM's activity #1 designs.
2. Assign class members to "supplier" groups and have each group assemble a component of the production plant. As they finish, have them hand over their models to the "set-up" team.
3. The set-up team is to physically assemble the plant. As problems arise with specific components they are to interact with the "suppliers" to correct the problem.
4. Let your instructor check each stage for final approval before connecting any power.
5. Follow the problem-solving process, as detailed in TAM #2, to alleviate any difficulties that arise.
6. Test run the model and debug it.
7. Operate the model in a simulated production run. Keep a record of what happens, just as a real company would.





TAM #10 - Summary

1. **Summary & Review Activities**

The impact of automation today, around you and around the world, is so significant that many people take it for granted or ignore it out of fear and/or confusion. Gradually however, you and the rest of society are becoming more aware of the significance of automation and of the potential it has for enhancing our lives. The activities you learn in this TAM will help you understand the basic nature of automation and put you in a position to transfer this understanding to other arenas as needed.

2. **Review Questions -- Test yourself!**

Instructions: Answer the following:

A. Define these terms:

1. Automation
2. Production simulation

B. List three historical events that used automation to improve a process.

1. ____
2. ____
3. ____

C. Match the following terms to their definitions.

1. Process _____	a. How a product is manufactured.
2. Handling _____	b. How materials are transported to machine.
3. Control _____	c. How process and handling are coordinated.

TAM #10 - Post-assessment

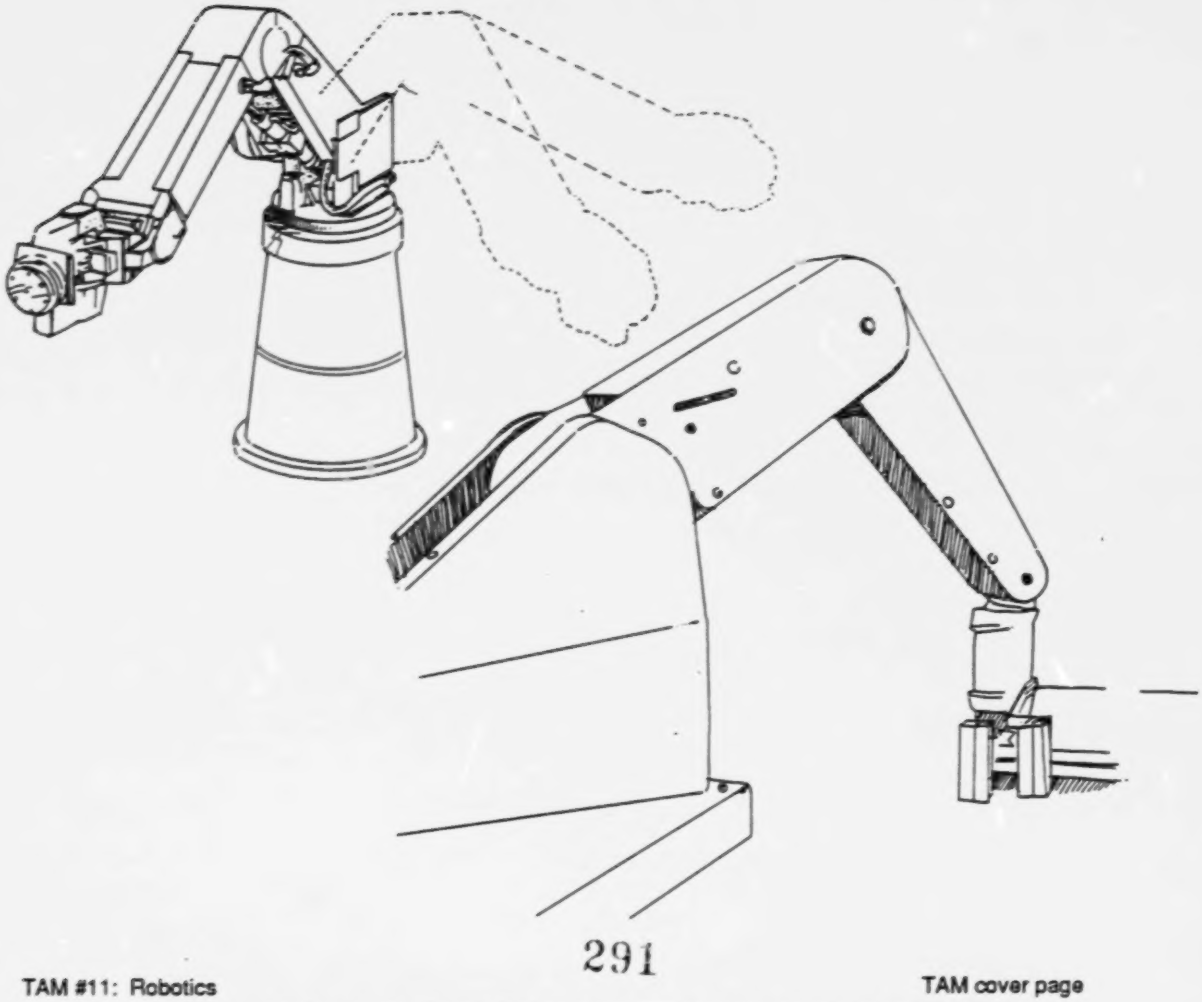
Instructions:

1. Have the instructor assess your group's production plant and discuss his/her assessment.
2. Complete the post-test for TAM #10.
3. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	Introduction to Materials and Processing Technology

Technology Activity Module #11

Robotics



TAM #11: Robotics

Instructor Component

Activity Objective: The purpose of this activity is to develop student capabilities in making and using robots suitable for a variety of manufacturing processes. Student activities include design, planning, fabrication, programming and utilization of robots.

Activity Competencies: By completing this TAM, the student will be able to:

1. Identify and describe the essential features of the equipment used in manufacturing technology and describe the major types and systems of robots. [5,IV]
2. Apply hand, mechanized and automated processes in the production of a product and operate robots to perform manufacturing tasks. [5,IV]
3. Explain the industrial processes employed to separate, combine, condition,form and fabricate materials into functional items. [5,V]
4. Devise a plan of procedures and operations for repetitive and quantity fabrication of products or components and construct a simple robot to work with it. [5,VI]
5. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,VI]
6. Read technical and working drawings and prints to secure needed information. [5,V]
7. Solve simulated industrial design or planning problems in the production of a product. [5,VI]
8. Demonstrate the safe use of tools, equipment, materials and processes that are related to production technology. [5,III]
9. Discuss production technology breakthroughs and future trends in industry and describe the operation of robots and programming methods. [5, XIII]
10. Employ CAD techniques and equipment to produce drawings for other output that meets appropriate standards. [5,VI,A]

Module Instructions

Introduction:

This activity is designed to combine design, fabrication and operation procedures as applied to robots. This robot may work within a rectangular envelope. It is to work on three axes: X, Y and Z. Its arms are to move from one side to the other on the X axis, in and out on the Y axis and up and down on the Z axis. It is recommended that the instructor integrate this activity with ongoing classroom presentations about automation and manufacturing technology. Other activities involved include: safety instruction, demonstration of robotic processes and programming, a pre-test and post-tests as well.

Safety Considerations:

Only minimal safety concerns apply to the small instructional robots typically found in school technology laboratories. Construction of a robot, however, will involve laboratory tools, so the usual safety precautions will need to be observed. One special note: It is recommended that only clean new syringes without attached needles be used.

Needed Materials:

1. **Supplies**
    - Hard wood
    - Counterweights
    - Water
    - Syringes (new!)
    - Hinges
    - Materials for fabrication
    - Paper
    - Plastic hose
    - Wood
    - String
    - Bolts & nuts
    - Pencil
    - Tubes
    - Goggles
    - Glue
    - Hardware items
2. **Equipment**
    - Bandsaw
    - Radial arm saw
    - Drill press
    - Table saw
3. **Handouts:**
    A. Student component of TAM #11
4. **Instructional Resources:**
    A. Film (review SME and National Bureau of Standards video for appropriate titles)

B. Books and Articles

Anderson, R. & Carter, L. (November, 1985). Robot construction using inexpensive materials. Industrial education. pp. 22-23.

Meys, J. W. (February, 1988). Add robotics -- without much expense. The technology teacher. pp. 25-28.

Neddenriep, T. (October, 1987). Construct a robot simulator for use in the general shop. School shop. pp. 20-21.

Potter, T. & Guild, I. (1983). Robotics. Usborne series in technology. London, UK: Usborne.

Salant, M. A. (1988). Introduction to robotics. St. Louis, MO: McGraw Hill.

Sheets, E. (1986). Technology activities. Cleveland, OH: Brodhead-Garrett Co. pp. 1-3.

Wright, T. R. (1987). Programming a robot. CITE Module series. Muncie, IN: Ball State University. pp. 1-8.

Wright, T R. (1987). Tea robot. CITE Module series. Muncie, IN: Ball State University. pp. 1-13.

C. A guest lecturer from an automated manufacturing plant would be interesting for students. Many larger firms now employ some degree of robotics

Management/Logistics:

1. Related TAM:

TAM #10, Automated Manufacturing

2. Evaluation/Grading

A. Pre- and post-test students.

B. Sixty percent weight on laboratory work and forty percent on the written examination is appropriate.

3. Suggested Schedule/Time

Two weeks is the suggested time for completion of this module but longer is appropriate if students are building sophisticated robots.

Key Instructional Suggestions:

1. Safety

Minimal safety concerns are involved in the operation of small school robots. The building of a robot, however, requires all the normal safety precautions typically used in laboratory work.

2. Motivation

A. The instructor should display all the projects in a school display for one week and/or enter them into a science/technology fair or other appropriate contest.

B. Take a field trip to a local plant that actually uses robots. This may require some imagination but look around and you will be successful, e.g., some hospitals are now using robots to help with medical lab tests.

3. Prerequisite Information

None, although a knowledge of Cartesian coordinates and geometry would be useful.

4. Demonstrations

- Building a robot
- Operating a robot

5. Reinforcement

Interact with the school's mathematics/geometry instructors to cooperatively work on the coordinate systems and geometry principles necessary to program robots.

6. Attitudes

- Encourage safety attitudes
- Encourage students to consider applications other than traditional ones for robots.

7. Remediation/Enrichment

Remediation: If slower students fall behind in programming, work with math and special needs instructors to take advantage of their resources for bringing geometry capabilities up to the needed levels.

Enrichment: Have advanced students build more complicated robots; consider a research paper or slide show on emerging robot technology; build models of different types of robots.

8. **Summary & Review**

   Review the procedure for building and operating a robot.

9. **Review Questions & Answers** *(Answers are in italics)*

   A. What are the work envelope classification of robots ? [M&P,T#11,5,III]
      1. *cylindrical coordinate robot*
      2. *rectangular coordinate robot*
      3. *spherical coordinate robot*
      4. *jointed-arm coordinate robot*

   B. There are three major classifications of motion for robots: What are they?
      1. *pick and place* [M&P,T#11,5,III]
      2. *point to point*
      3. *continuous path*

C. What is the most common type of control used for industrial robots?
Microprocessor control [M&P,T#11,5,III]

TAM #11 - Test Keys (Robotics)

TAM #11 - Pre-test answers

1. d 2. d

3. The following in any order:

   a. *manipulator* b. *controller* c. *power sources* d. *end effectors*

4. The following in any order:

   a. *electric* b. *pneumatic* c. *hydraulic*

5. *servo controlled or non-servo controlled*

TAM #11 - Post-test answers

1. d 2. g

3. *Cartesian*

4. The following in any order:

   a. *spray painting* b. *welding* c. *loading/unloading*

   d. *handling materials* e. *assembling*

Date: _______ Class: ________________ Name: ________________

TAM #11 - Pre-test (Robotics)

Instructions: Circle the letter of the correct answer.

1. A robot is a/an: [M&P,T#11,5,III]

    a. programmable machine
    b. multipurpose machine
    c. electromechanical machine
    d. all of the above

2. Robots are used for work that is: [M&P,T#11,5,III]

    a. boring
    b. repetitious
    c. dangerous
    d. all of the above

Instructions: Fill in the blanks with the correct answers.

3. Name the four components of typical robot systems: {M&P,T#11,5,IV]

    a. ____________________
    b. ____________________
    c. ____________________
    d. ____________________

4. The three most used power sources for robot systems are: [M&P, T#11, 5, IV]

    a. ____________________
    b. ____________________
    c. ____________________

5. Manipulator movements are either ____________________ or ________________. [M&P,T#11,5,IV]

Date: ________ Class: ________________ Name: ________________

TAM #11 - Post-test (Robotics)

Instructions: Please read each item and circle the letter of the correct answer.

1. The levels of robots can be identified as: [M&P,T#11,5,III]

   a. simple
   b. medium
   c. complex
   d. all of the above
   e. none of the above

2. Robots can be classified by: [M&P,T#11,5,III]

   a. number of axes of movement
   b. load capacity
   c. cycle time
   d. accuracy
   e. power source
   f. type of controller
   g. all of the above

Instructions: Fill in the blanks with the correct answer.

3. The movement of a robot's manipulator is based on the ____________________ coordinate system. [M&P,T#11,5,IV]

4. The most common industrial applications of robots are: [M&P,T#11,5,III]

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________

TAM #11: Robotics

Student Component

Introduction:

A robot is a manufacturing tool that creates movement when power is applied. Robots can be simple machines which are useful because they move things from one location to another or they can be very complex. To perform a task, robots must be programmed with various information or programs. The programing can be done in three ways: 1. on-line programming, 2. off-line programs and 3. computer graphic interface programs.

In this module, you will design, build and operate a robot. Also, be prepared to simulate on-line programming to direct a robot to perform an activity.

Competencies: Following completion of this TAM, you will be able to:

1. Identify and describe the essential features of the equipment used in manufacturing technology and describe the major types and systems of robots. [5,IV]
2. Apply hand, mechanized and automated processes in the production of a product and operate robots to perform manufacturing tasks. [5,IV]
3. Explain the industrial processes employed to separate, combine, condition,form and fabricate materials into functional items. [5,V]
4. Devise a plan of procedures and operations for repetitive and quantity fabrication of products or components and construct a simple robot to work with it. [5,VI]
5. Employ a systematic design process to produce a product that meets the assigned design specifications. [5,VI]
6. Read technical and working drawings and prints to secure needed information. [5,V]
7. Solve simulated industrial design or planning problems in the production of a product. [5,VI]
8. Demonstrate the safe use of tools, equipment, materials and processes that are related to production technology. [5,III]
9. Discuss production technology breakthroughs and future trends in industry and describe the operation of robots and programming methods. [5, XIII]
10. Employ CAD techniques and equipment to produce drawings for other output that meets appropriate standards. [5,VI,A]

Module Overview:

This module contains two activities. They are:

1. Making a robot
2. Operating a robot

In this module, the class will build a robot. The class will be divided into several groups of students and each group will:

1. Study carefully the designs and bill of materials
2. Develop a procedure for building the robot
3. Select a sub-system of a robot for each group member to fabricate
4. Get the materials and supplies needed and build the robot

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and by reviewing the steps of procedure
2. Complete the pre-test given by your instructor.
3. Do Activity #1 - Making a robot.
4. Do Activity # 2 - Operating a robot.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. Class Presentations

- Distinction between robotics and automated systems
- Importance of robotics
- Components used in robots and automated systems
- Various power supply systems

2. Demonstrations

- Building a robot
- Operating a robot

3. Safety Concerns

- Basic tool safety precautions and eye protection
- DC power meter
- Analog circuits and digital to analog circuits.

4. Personal Activity

Before beginning work on these activities, it is recommended that you read:

Anderson, R. & Carter, L. (November, 1985). "Robot construction using inexpensive materials." Industrial education. pp. 22-23.

Meys, J. W. (February, 1988). "Add robotics -- without much expense." The technology teacher. pp. 25-28.

Neddenriep,T. (October, 1987). "Construct a robot simulator for use in the general shop." School shop. pp. 20-21.

Potter, T. & Guild, I. (1983). Robotics. Usborne series in technology. London, UK: Usborne.

Sheets, E. (1986). Technology activities. Cleveland, OH: Brodhead-Garrett Co. pp. 1-3.

Wright, T. R. (1987). Programming a robot. CITE Module series. Muncie, IN: Ball State University. pp. 1-8.

Wright, T. R. (1987). Tea robot. CITE Module series. Muncie, IN: Ball State University. pp. 1-13.

5. Other

Additional information will be provided to you by a films and/or instructor demonstrations/presentations.

Glossary:

Arm	An interconnected set of robot parts/links and powered joints comprising a manipulator, which supports or moves wrists and hand or end effectors.
Automation	The controlled operation of an apparatus, process or system by mechanical or electronic devices to take the place of human observation, effort and decision.
Controller	An information-processing device whose inputs are both desired and measured. Typically position, velocity or other pertinent data are input variables in a process whose outputs are drive signals to a controlling motor.
Manipulator	A mechanism, usually consisting of a series of segments jointed or sliding relative to one another, for the purpose of grasping and moving objects, usually in several degrees of freedom.
Program	A sequence of instructions to be executed by the computer or robot controller to control a machine or a process.
Programming	The act of developing the set of instructions needed to control the robot to perform its intended task.
Robot	A mechanical device which can be programmed to perform some task of manipulation or locomotion under automatic control.
Work Envelope	The set of points representing the minimum and maximum extent or reach of the robot hand or working tool in all directions.

Needed Materials:

1. **Supplies**

   - Hard wood
   - Counterweights
   - Water
   - Syringes (new!)
   - Hinges
   - Materials for fabrication
   - Paper
   - Plastic hose
   - Wood
   - String
   - Bolts & nuts
   - Pencil
   - Tubes
   - Goggles
   - Glue
   - Hardware items

2. **Equipment**

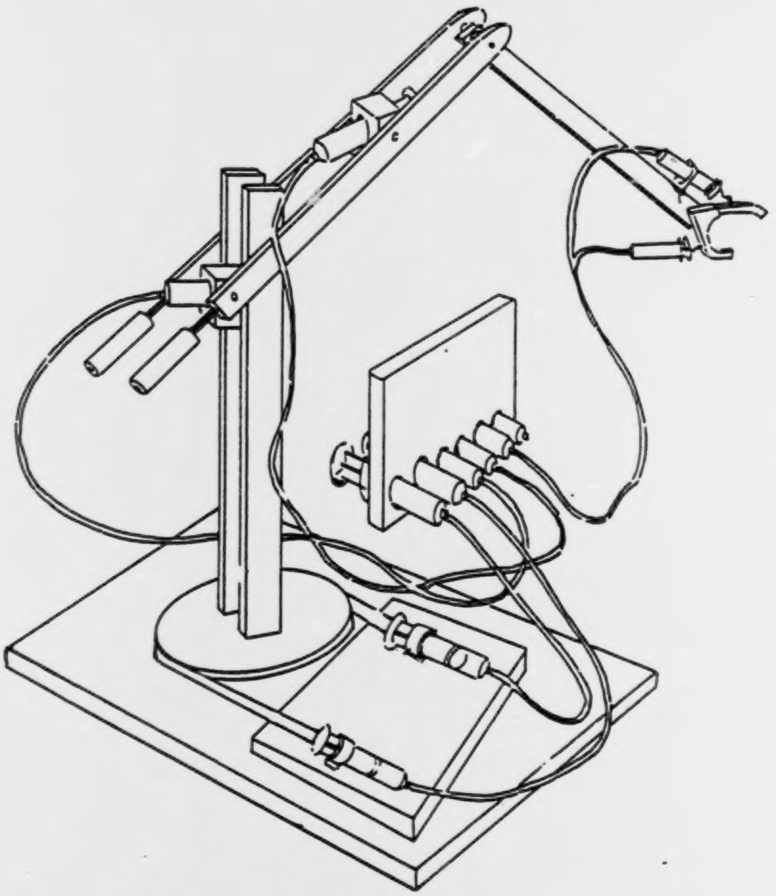
   - Bandsaw
   - Radial arm saw
   - Drill press
   - Table saw

3. **Handouts:**

   A. Student component of TAM #11

TAM #11: Robotics

Activity #1 - Making a Robot: Plan of Procedure[†]



Step 1: Build the Base and Power Supply (Syringe) Board, e.g.:

1. Square base and power supply board
2. Glue a block to the base for spring support
3. Position it approximately centered on the base
4. Bore a hole centered from the back edge of the base
5. Cut acrylic tubing to the required length
6. Cut a notch to required length around the tube and the required length from the end
7. Glue the acrylic tube into the hole

Step 2: Build an upper arm and forearm assembly e.g.:

1. Cut the upper arm from the dowel rod
2. Cut forearm from a hardwood
3. Join forearm and upper arm at elbow by cutting slot in top of 3/4" dowel
4. Secure the joint with 1/4" dowel pin for the joint to pivot

([†]procedure from Neddenriep, 1987).

Step 3: Construct the gripper, e.g.:

1. Cut a piece of 1/4" plywood into T-shape. The cross of the T should match the shape of the hinge
2. Bolt the short side of the offset chest hinge to the T-shaped plywood
3. Drill a hole in the exposed part to attach a gripper linkage
4. Bolt the long side of the chest hinge to the end of the forearm
5. Glue sandpaper to the inside of the gripper faces to give the jaws more holding ability

Step 4: Attaching Syringes, e.g.:

(Notice: Use only clean, new syringes)

1. Determine syringe size of each application, e.g., 6 cc through 20 cc syringes for the power supply and 3 cc through 6 cc for drive syringes (1, 2, & 3)
2. Cut light-gauge sheet metal to size and shape around syringe body.
3. Secure to the power supply board with wood screw
4. To mount drive syringe #1, (which controls the vertical movement of the forearm, cut a piece of sheet metal to the size
5. Bend the form yoke
6. Fasten the sheet metal yoke to the upper arm
7. Mount drive syringe #2, which controls base rotation. Position drive syringe #2 so that when the handle is pulled out, it will align with the back of the acrylic tubing
8. Drill a hole in the end of the base rotation syringe handle and insert the head end of the finish nail
9. To mount drive syringe #3, (which controls the gripper), cut a piece of 3/4" pine to the required size, diagonally
10. Glue the block
11. Secure drive syringe #3 with epoxy glue to the diagonally cut block
12. Use light-gauge wire to secure the syringe handles to the hole in the sheet metal so the gripper can be driven

Step 5: Connecting hoses, e.g.:

1. Aquarium hose 3/16" should fit tightly over the end of the syringe. If care is taken by making movements smoothly, the power supply syringes will easily drive the robot mechanism.

Step 6: Testing and Painting, e.g.:

1. After completing the construction, the students should test the function of each moving part. Make any necessary corrections and adjustments. Mask off all the unwanted area not to be painted, then spray the paint on the exposed parts.

TAM #11: Robotics

Activity #2 - Operating a Robot: Plan of Procedure

Operating the Robot

For this activity, the class will be divided into four groups. Each group will complete the following tasks:

1. Learn the capabilities of their robot simulator

2. Develop a task description worksheet for operating the robot

3. Assign each member of the group to each of the following robot controls, e.g.:
    a. Pivot Control - Plunger #1
    b. Full Arm Control - Plunger #2
    c. Short Arm Control - Plunger #3
    d. Gripper Control - Plunger #4

4. Carefully study the task and program

5. Set the robot in its start position, e.g.:

Plunger	Position
Pivot	Pulled all the way out
Full arm	Pulled all the way out
Short arm	Pushed all the way in
Gripper	Pushed all the way in

6. Operate the robot by using a program developed by a student team

7. Evaluate the outcomes

Programming the Robot (simulating on-line programming)

The class will be divided into four groups and each group is to complete the tasks below:

1. Prepare a basic program for the robot to finish the given task
2. Walk the robot through the steps using the planned sequence of movements
3. Record the movement of the plunger for each movement on your worksheet
4. Test the program by operating the robot
5. Adjust the program as required
6. Exchange your program with another group
7. Try their program on the robot
8. Complete the appropriate section of the group's worksheet
9. Return the worksheet to the original group
10. Review programming the robot (Wright, 1987)

TAM #11 - Summary

1. **Review & Summary Activities**

   Robotics provide fun and challenges to both you and your classmates. This activity module provides you with practical opportunities for incorporating technology into a manufacturing activity. However, the greatest asset this TAM provides is that it has introduced you to many new concepts.

   Also, keep in mind that the robot system presented in this module is a very low-cost, simple way to introduce you to the concepts and construction of robotics. Many more complicated implementations exist, but now you have mastered the basics.

2. **Review Questions – Test yourself!**

   1. How fast are robots?
   2. Using any robot classification system, write the description of a cylindrical coordinate robot.
   3. Describe the difference between the path that a point to point robot and a controlled path robot will take between the same two programmed points.
   4. For what application is the continuous path robot normally used?

TAM #11 - Post-assessment

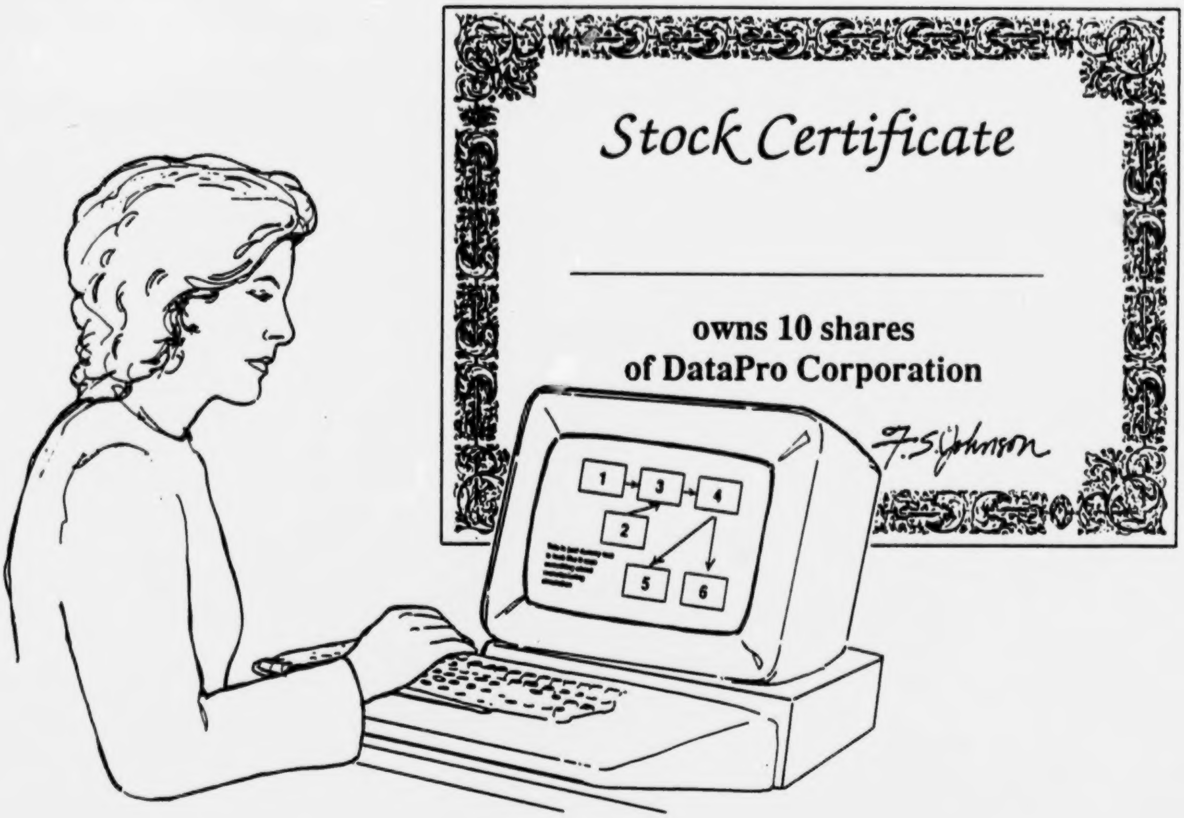
Instructions:

1. Have the instructor complete the evaluation and discuss discrepancies between the two assessments.
2. Complete the post-test for TAM #11.
3. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #12

Mass Production


Stock Certificate
owns 10 shares
of DataPro Corporation
F.S. Johnson
1
3
4
2
5
6

TAM #12: Mass Production

Instructor Component

Activity Objective: The main objective of this activity is to introduce students to the processes and procedures involved in the mass production of goods and/or services. Some of the processes they will experience include: designing, refining product ideas, brainstorming, creating prototypes and actual mass production.

Activity Competencies: By completing this TAM, the student will be able to:

1. Place manufacturing and construction technology in the broad context of industrial technology. [6,I]
2. Explain the fundamental characteristics, roles, structure and organization of the manufacturing and construction industry. [6,I]
3. Explain the steps and technology involved in major American applications of materials and processing technology. [6,III]
4. Apply standard industrial quality control procedures to items produced in the laboratory. [6,IV]
5. Solve materials and processing technology problems through problem solving, creative thinking and decision-making processes. [6,V]
6. Demonstrate the safe use of equipment, tools, materials and processes that are related to materials and processing technology. [6,VIII]
7. Apply maintenance and servicing techniques to goods and structures. [6,VIII]
8. Relate the activities of manufacturing and construction technology to local, state and national developments. [6,IX]
9. Experiment with processes, equipment and materials to develop insight into new and advancing technologies. [6,IX]

Module Instructions

Introduction:

This activity is designed to have students actively participate in designing, material processing and producing products in a simulated manufacturing setting. It is suggested that this activity be correlated with a series of classroom presentations. The activities include: safety instruction, design, brainstorming, demonstrations and procedures, pre-test and post-tests and production.

Safety Considerations:

The safety aspect of this TAM's activity is extremely important because of increased speed in, and frequency of, cutting operations and typically the multiple cutting of small parts. In addition, the operators may not be as skilled as possible and there will be much going on to distract them. The instructor must therefore be certain to reinforce the key safety precautions every day.

Needed Materials:

1. Supplies

- Pine, S2S
- Plexiglass
- Wood balls
- Knobs and handles
- Glue
- Finish
- Fasteners
- Sandpaper
- Paper
- Pen/Pencil
- Eraser

2. Equipment

- Table saw
- Radial saw
- Power miter box
- Jointer
- Sander
- Drill press
- Goggles
- Jack plane
- Aluminum
- Jig
- Band saw
- Rip saw
- Cross cut saw
- Clamp
- Fixture
- Brace

Note: Use equivalent hand tools for younger and/or inexperienced students.

3. Handouts

A. Student component of TAM #12.

4. Instructional Resources

A. Film (Select an appropriate item from the Society of Manufacturing Engineers', National Bureau of Standards, or other media sources per Section III, part 4.)

B. Books and Articles

Goetsch, D. L. & Nelson, J. A. (1987). Technology and you. Albany, NY: Delmar. ISBN # 0-8773-2662-9. pp. 139-174.

Wright, R. T. (1984). Manufacturing. IL: Goodheart-Wilcox. ISBN # 0-87006-493-2, pp. 28-81.

Wright, R. T. (1985). Exploring manufacturing: Student manual. IL: Goodheart-Wilcox. ISBN # 0-87006-534-3.

Wright, R. T. (1985). Exploring manufacturing. IL: The Goodheart-Wilcox. ISBN # 0-87006-533-5, pp. 143-155.

Wright, R. T. & Henak, R. M. (1985). Exploring production. IL: Goodheart-Wilcox. ISBN # 0-87006-530-0, pp. 143-155.

C. A guest lecturer from any mass production environment. Consider factories and manufacturer home plants near you.

Management/Logistics:

1. Related TAMS

TAM 1, First Week Production Activity; TAM 9, Jigs & Fixtures; TAM 10, Automated Manufacturing; TAM 13, Forming and Managing a Company

2. Evaluation/Grading

A. Pre- and post-test taken by students.
B. The quality of design/sketch.
C. Quality of craftsmanship of prototype and products.

3. Suggested Schedule/Time

The activities should be performed in two weeks if all jigs, fixtures and designs are pre-established. Otherwise, this activity could be appropriately extended to 4-6 weeks.

Key Instructional Suggestions:

1. Safety

Because of the high degree of safety required by this TAM, the instructor should be careful to insure that all students have been taught basic hand tool and machine operation. All students should then be tested to insure that they can demonstrate the safe usage of the tools, materials, machines and devices involved in the mass production activity. Instructors should reinforce their concern for safety by appointing a safety official within each simulated company.

2. Motivation

Try to run the mass production activity with two concurrent classes. Role play first shift--second shift or company A vs. company B tension. Competition is a natural motivator. Alternatively, consider establishing the profit motive by having students sell the results of their work and then devising a "profit sharing" plan.

Display all articles for public view in school, at local store/mall -- make some extras and offer for sale to the general public.

3. Prerequisite Information

Students should have a working familiarity with the laboratory's tool/machine complement as well as some understanding of how manufacturing operates.

4. Demonstrations

- Safety and tool operation
- Jig and fixture building
- Mechanical drafting and computer applications, e.g., CAD.

5. Reinforcement

Research and development, sales and marketing, shipping, packaging and after-market service all represent areas that could easily be linked to other school subjects.

6. Attitudes

Safety, quality, craftsmanship and work ethic are key attributes that need to be stressed. Deliberate instruction should be focussed on these goals.

7. Remediation/Enrichment

A. Remediation: Assign students needing help to easier activities or team them with more advanced ones.

B. Enrichment: There are countless manufacturing-related projects available for enrichment. Research papers, work procedure enhancements and jig/fixture improvement are but some of the possibilities.

8. Summary & Review

Review the major steps in the mass production process. Summarize the key variables in the cost effectiveness of production, marketing and after-market service. Highlight factors relevant to business, industry and the social impact of technology.

9. Review Questions & Answers

A. What trends are emerging in the technological arena most closely related to the mass production activity?

- *CIM*
- *Less machining*
- *Empowering of the worker*
- *More forming processes*
- *More "one-step" processes*

B. How and why is the class mass production activity different than what occurs in real life?

- *Scale*
- *Capitalization*
- *Quantity*
- *Human resources*
- *Risk factor*

Date: _____ **Class:** __________________ **Name:** __________________

TAM #12 - Pre-test (Mass Production)

Instructions: Circle the correct answers.

1. Changing the form of materials is done in series of acts called:
   a. Products.
   b. Processes.
   c. Production.
   d. Transportation.

2. The manufacturing process comprises:
   a. Changing the form of materials.
   b. Assembling components.
   c. Processing of raw materials.
   d. All of the above.

3. The manufacturing industry involves:
   a. Suppliers.
   b. Distributors.
   c. Sub-contractors.
   d. All of the above.

4. The major areas of activity that transforms ideas into products are:
   a. Research and development.
   b. Production.
   c. Marketing.
   d. All of the above.

5. The production of a highly individualized product such as a luxury limousine is classified as:
   a. Custom manufacture.
   b. Intermittent manufacture.
   c. Continuous manufacture.
   d. Construction manufacture.

6. The design process consists of:
   a. Defining the problem and getting ideas out.
   b. Choosing the best idea and making the drawing.
   c. Producing a complete model and testing it.
   d. All of the above.

7. The methods of temporarily or permanently combining parts are:
   a. Mechanical assembly processes.
   b. Bonding processes.
   c. Welding processes.
   d. All of the above.

Date: _____ Class: ________________ Name: ________________

TAM #12 - Post-test

Instructions: The following are true/false questions. Circle the correct answer.

1. T F The two major types of manufacturing processes are primary processes and secondary processes.
2. T F Primary processing changes standard industrial stock into raw materials.
3. T F Secondary processing is a 'form utility' activity. It changes standard stock into useful finished products.
4. T F Custom manufacture is an expensive way to produce products and requires highly skilled labor and general purpose machines.
5. T F Assembling processes are the processes which permanently or temporarily join two or more parts.
6. T F The planning of manufacturing processes must include separating, combining and forming considerations.

TAM #12 - Test Keys

TAM #12 - Pre-test answers

1. b 2. d 3. d 4. d 5. a

6. d 7. c

TAM #12 - Post-test answers

1. T 2. F 3. T 4. T 5. T

6. F

TAM #12: Mass Production

Student Component

Introduction:

A mass production project presents a challenge to you and your classmates. It is quite different to produce a large number of products compared to making just one. Try to come up with a "hot" idea that will sell very well -- use your imagination -- there's money to be made! This activity will teach you the fundamentals of making many items within the shortest possible time.

Competencies: Following the completion of this TAM, you will be able to:

1. Place manufacturing and construction technology in the broad context of industrial technology. [6,I]
2. Explain the fundamental characteristics, roles, structure and organization of the manufacturing and construction industry. [6,I]
3. Explain the steps and technology involved in major American applications of materials and processing technology. [6,III]
4. Apply standard industrial quality control procedures to items produced in the laboratory. [6,IV]
5. Solve materials and processing technology problems through problem solving, creative thinking and decision-making processes. [6,V]
6. Demonstrate the safe use of equipment, tools, materials and processes that are related to materials and processing technology. [6,VIII]
7. Apply maintenance and servicing techniques to goods and structures. [6,VIII]
8. Relate the activities of manufacturing and construction technology to local, state and national developments. [6,IX]
9. Experiment with processes, equipment and materials to develop insight into new and advancing technologies. [6,IX]

Module Overview:

This module contains three activities that apply to the mass production of a stool or gumball dispenser. However, with instructor's permission, you could easily substitute an entirely different product or service. In any case, your class is responsible to detail the outline presented here and make it specific to their own design.

Additional information will be provided to you by film/video and instructor presentations.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 -- Mass producing a stool.
4. Do Activity # 2 -- Mass producing a gumball dispenser.
5. Review and summarize.
6. Complete post-assessment procedure.

Key Information:

1. Class Presentations

- Introduction of mass production concepts
- Mass production planning
- Concept of "stock" items and engineering materials

2. Demonstrations

- Setup of assembly line
- Jigs and fixtures
- Multiple cutting operations
- Air extracting parts

3. Safety

Be particularly careful to employ all safety precautions. With all the activity of mass production going on around you, it would be easy to get distracted.

4. Personal Activity

Before beginning work on these activities it is recommended that you read:

Lux, D. & Ray, W. (1971). The world of manufacturing. Bloomington, IL: McKnight . ISBN # 87345-551-7, pp. 1-21.

Wright, R. T. (1985). Exploring Manufacturing. Text and Student Manual. IL: Goodheart-Wilcox. ISBN # 0-87006-533-5, pp. 143-155.

Wright, R. T. & Henak, R. (1985). Exploring Production. IL: Goodheart-Wilcox. ISBN # 0-87006-530-0, pp. 143-155.

5. Other

Research how technology affects American families. Where can a computer be used? Can high tech fasteners be used? How do companies market, sell and service their products? Explore corporate profit concepts. Study global market concepts.

Glossary:

Custom Manufacturing	Production activity that yields a unique or highly individualistic product, e.g., luxury homes, limousines, built-in furniture, etc.
Fixture	A setup on a machine used to make multiple parts.
Industrial Revolution	A period of time around the mid to late 1800s during which production of goods began to be done in factories instead of homes.
Jig	A device for holding material during assembly.
Joint	A point at which two pieces are joined in an assembly.
Manufacturing	A process of making products.
Mass Production	Producing large quantities of identical products in a short time.
Processes	Activities performed to change materials according to plan.
Stress	The intensity of force inside a body which will resist a change in its shape.

Needed Materials:

1. Supplies

- Pine, S2S
- Plexiglass
- Wood balls
- Knobs and handles
- Glue
- Finish
- Fasteners
- Sandpaper
- Paper
- Pen/Pencil
- Eraser

2. Equipment

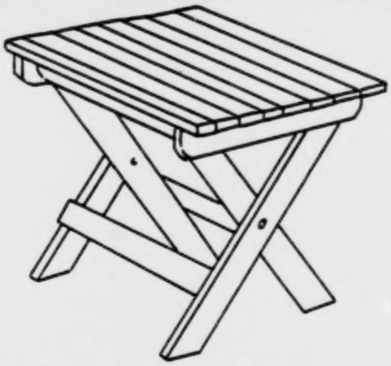
- Table saw
- Radial saw
- Power miter box
- Jointer
- Sander
- Drill press
- Goggles
- Jack plane
- Aluminum
- Jig
- Band saw
- Rip saw
- Cross cut saw
- Clamp
- Fixture
- Brace

3. Handouts

A. Student component of TAM #12.
B. Drawing of product to be built (student developed)
C. Plan of manufacturing procedure (student developed)

TAM #12: Mass Production

Activity #1A - Mass Producing a Stool - Basics: Plan of Procedure



1. Organize the company.
   See TAM #13 for details

2. Plan the production flow by sequencing the major manufacturing operations. These are likely to include, but are not limited to, the listed steps below: Note they are not presented in order!

   - Finish stock to size
   - Cut grooves
   - Screw installation
   - Drill a hole
   - Finishing - dip or stain
   - Cut leg end angles
   - Inspection
   - Secure stock
   - Plane to thickness
   - Rip to width
   - Crosscut to length
   - Counter bore holes
   - Rough cut to length
   - Mark stock for most efficient cutting
   - Label parts
   - Wipe dry
   - Install stove bolts
   - Round ends
   - Transport, between workstations
   - Rework
   - Joint edge
   - Inventory supplies and products

3. Flow chart the overall production using TAM #12's Flow Process Chart Handout.

4. Custom manufacture a prototype.

5. Revise your production plans to better produce the product in a mass production mode.

6. Detail each step/operation in the production plan using the following format:

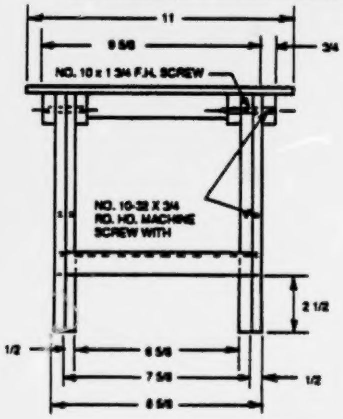
Step #	Description	Process to be performed	Jigs/Fixtures Used	Notes

7. Build the needed jigs and fixtures.

8. Secure supplies and PRODUCE!

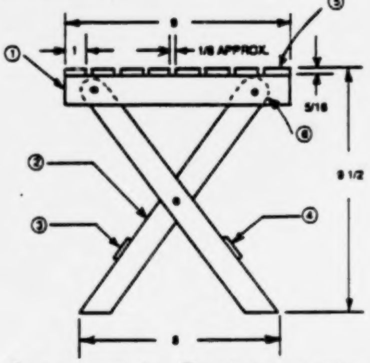
TAM #12: Mass Production

Activity #1b - Mass Producing a Stool - Details: Plan of Procedure


11
9 5/8
3/4
NO. 10 x 1 3/4 F.H. SCREW
NO. 10-32 X 3/4
RD. HD. MACHINE
SCREW WITH
2 1/2
1/2
6 5/8
7 5/8
1/2
8 5/8

Material List per Stool

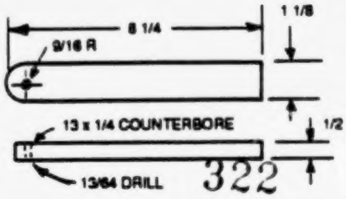
Wood parts needed:
Legs -- 4: 1/2" x 1" x 11 3/4"
Brace A -- 1: 1/2" x 8 1/2"
Brace B -- 1: 1/2" x 1" x 7 1/2"
Seat Supports -- 4: 1/2" x 1" x 8 1/4"
Seat Halves -- 2: 1/2" x 4 1/2" x 11"
Handle -- 1: 1" dia. x 5 1/2"
Fasteners:
4 --- 1/4" x 3/4" R.H. stove bolts with nuts
12 --- #6 x 1" F.H. wood screws
2 --- #10 x 2 1/2" R. H. wood screws


8
①
1
1/8 APPROX.
⑤
5/16
⑥
②
9 1/2
③
④
8

1. Produce part 1: Seat supports, 1/2" x 1-1/8" x 8-1/4", quantity = 4

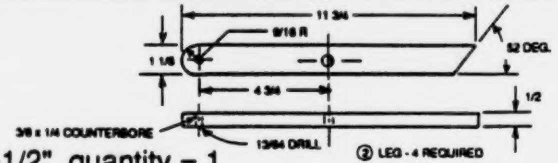
Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Rough cut to length a multiple of the part that is easy to handle				
3. Joint one edge straight				
4. Rip to width				
5. Crosscut to length				
6. Drill both holes				
7. Counter bore				
8. Round ends				
9. Sand				

① SEAT SUPPORTS - 4 REQUIRED


8 1/4
1 1/8
9/16 R
13 x 1/4 COUNTERBORE
1/2
13/64 DRILL

2. Produce part 2: legs, 1/2" x 1" x 11-3/4", quantity = 4

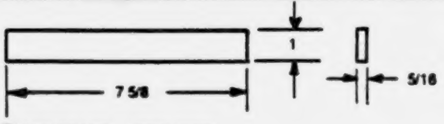
Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Rough cut to length a multiple of the part that is easy to handle				
3. Joint one edge straight				
4. Rip to width				
5. Crosscut to length				
6. Drill both holes				
7. Counter bore both holes on opposite sides				
8. Round the ends				
9. Sand the piece				



② LEG - 4 REQUIRED

3. Produce part 3: leg brace, 1/2" x 1" x 7-1/2", quantity = 1

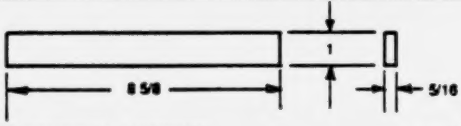
Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Rough cut to length a multiple of the part that is easy to handle				
3. Joint one edge straight				
4. Rip to width				
5. Crosscut to length				
6. Sand the piece				



③ LEG BRACE - 1 REQUIRED

4. Produce part 4: leg brace, 1/2" x 1" x 8-1/2", quantity = 1

Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Rough cut to length a multiple of the part that is easy to handle				
3. Joint one edge straight				
4. Rip to width				
5. Crosscut to length				
6. Sand the piece				



④ LEG BRACE - 1 REQUIRED

5. Produce part 5: Seat slats, 5/16" x 1" x 11", quantity = 8

Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Rough cut to length a multiple of the part that is easy to handle				
3. Joint one edge straight				
4. Rip to width				
5. Crosscut to length				
6. Sand				

6. Produce part 6: Handle, 1" diameter x 5-1/2", quantity = 1

Operation	Machine or Tool	Jig	Fixture	Gage
1. Secure stock				
2. Cut to length				
3. Drill hole in center of each end				
4. Sand				

7. Assembly operations

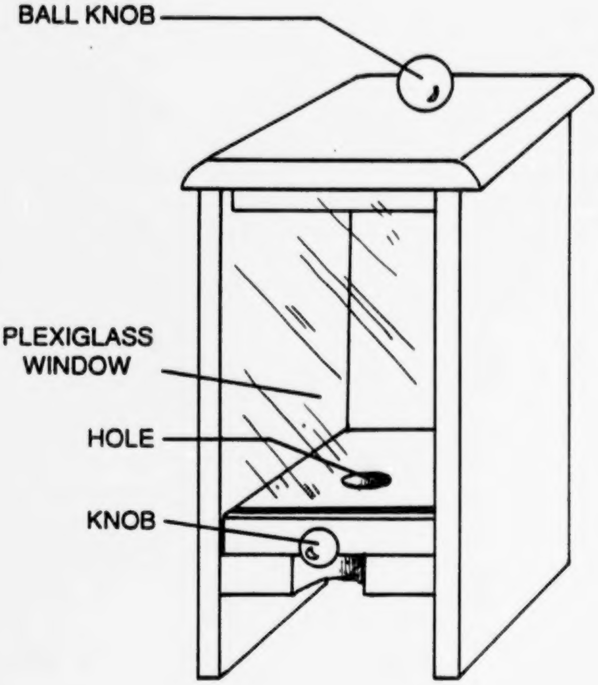
Operation	Machine or Tool	Jig	Fixture	Gage
1. Attach legs and brace A with screws				
2. Attach legs and brace B with screws				
3. Attach seat half to supports A with screws, Counter bore out				
4. Attach seat half to supports B with screws				
5. Dip finish all subassemblies and handle				
6. Attach seat half and supports B to dowel legs and brace B using 2 #10 x 2-1/2" wood screws				
7. Attach seat half and supports B to legs and brace A using 2-1/4" x 3/4" bolts with nuts				
8. Connect legs and brace A to legs and brace B using 2-1/4" x 3/4" bolts with nuts				
9. Cut angles on legs				

TAM #12: Mass Production

Activity #2 - Mass Producing a Gumball Dispenser: Plan of Procedure

Note: Students are to supply the details

1. Plan the manufacturing process.
2. Develop tooling (jigs & fixtures).
3. Secure stock.
4. Produce standard stock
5. Cut parts to size.
6. Smooth and treat parts.
7. Assemble product.
8. Finish product.



TAM #12 - Summary

1. Review & Summary Activities

In this TAM you produced multiple copies of individual parts of a product. Then you assembled the final product. This process leads to the idea of interchangeable parts. Interchangeable parts are parts that are exactly the same or look like one another. For this exercise to work, parts produced in a mass situation must be interchangeable.

The mass production exercise is an activity that teaches you much about technology. The concepts that you learned in this TAM are important for the future. This importance is based on your identification of needs and then the subsequent application of available knowledge, technology and resources. The overall goal is an attempt to satisfy our needs as efficiently as possible.

2. Review Questions -- Test yourself!

A. What occurs when parts are inaccurately cut?

B. Why is precise work important?

C. List and briefly describe the five major inputs to manufacturing.

D. Explain three reasons why manufacturing is important.

E. What are thew three major steps in changing the form of materials?

TAM #12 - Post-assessment

Instructions:

1. Have the instructor assess your class and mass production activity. Then discuss its strengths and weakness and how you would improve the process the next time.
2. Complete the post-test for TAM #12.
3. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Manufacturing Technology

Production Flow Process Chart

Company: ____________________

Product: __________________________ Date: ______

Sub-assembly: ____

Part: ____

Analyst: __________________ Checked by: ________________

Step #	Step Description	Operation	Transrtn	Inspectin	Wait	Storage	Operator	Inspector	Jigs/Fixture
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			
		○	⇨	□	D	▽			

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module #13

Forming & Managing a Company

TECH-PRO CORPORATION

TAM #13: Forming & Managing a Company

Instructor Component

Activity Objective: The purpose of this activity is to develop student competencies in establishing and managing a manufacturing or other enterprise. The processes include: company organization, management, system analysis, research and development, production planning, marketing, financing and control.

Activity Competencies: By completing this TAM, the student will be able to:

1. Explain the fundamental characteristics, roles, structure and organization of the manufacturing and construction industry. [6,I]
2. Explain the steps and technology involved in major American applications of materials and processing technology. [6,III]
3. Apply standard industrial quality control procedures to items produced in the laboratory. [6,IV]
4. Solve materials and processing technology problems through problem solving, creative thinking and decision making processes. [6,V]
5. Relate the activities of manufacturing and construction technology to local, state, and national developments. [6,VI]

Module Instructions

Introduction:

This TAM guides students through the forming and managing of a manufacturing or other enterprise. This module should be used to guide student activity over a longer period of time, preferably one that initially precedes, and then overlaps, with a mass production activity. The activities in this module include pre- and post-test, application of planning and set-up processes, and subsequently, operational procedures.

Safety Considerations:

Although there are minimal safety risks involved in forming a company, the instructor is advised to point out that students should deliberately plan to incorporate a safety office in their organization.

Needed Materials:

1. **Supplies**
   - Pen/pencil
   - Paper
   - Eraser
   - Transparencies

2. **Equipment**
   - Chart pad and easel

3. **Handouts**

   A. Student component of TAM #13

4. **Instructional Resources**

   A. Film, "The Story of Human Enterprise," also Phillips Petroleum series, see Section III, part 4.

   B. Books and Articles

   Amrine, H. K.; Ritchey, J. A. & Moodie, C. L. (1987). Manufacturing organizations and management. NJ: Prentice-Hall. ISBN # 0-13-5558144-x 025. pp. 1-37.

   Falk, R. F. (1976). Industrial enterprise. Madison, WI: Wisconsin Bureau for Vocational and Career Education. pp. 4-8

   Lux, D. & Ray, W. (1971). The world of manufacturing. Bloomington, IL: McKnight. ISBN 8-7345-551-7. pp. 29-52.

   Nelson R. & Selvidge, L. (1986). The manufacturing enterprise. Statesboro, GA: Southern University Press. pp.1-9.

   Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Wilcox. pp. 127-133

   Wright, R. T. & Henak, R. M. (1985). Exploring production. South Holland, IL: Goodheart-Wilcox. ISBN # 087006-532-7. pp.34-50.

   C. Invite local entrepreneurs to the class and have them highlight the steps they used in establishing their enterprise. Alternatively, invite a representative of the Junior Achievement Program, the chamber of commerce, or the regional economic development agency.

Management/Logistics:

1. **Related TAMS:**

   TAM #12, Mass Production; TAM #1, First Week Production Activity

2. **Evaluation/Grading**

   Use the pre- and post-tests to assess student knowledge and then augment this measure with rewards for actively participating in the TAM's activity.

3. **Suggested Schedule/Time**

   It is suggested that two to eight weeks be allocated for this TAM. Note, however, that some of this time can be concurrent with the actual mass production activity for which this organizational work is a precursor.

Key Instructional Suggestions:

1. **Safety**

   Stress the need to consider safety in the planning of production. Also point out corporate responsibility for product safety and the liability that can result from problems.

2. **Motivation**

   Take students on a field trip to privately and publicly owned companies or invite local managers in to discuss the set-up, finance and management of their companies.

3. **Prerequisite Information**

   None

4. **Demonstrations**

   - How to run a corporate meeting
   - Forming a company
   - Managing a company

5. **Reinforcement**

   Interact with the school's business and marketing teachers to see how their resources and activities might be used to reinforce this TAM's activity. Consider joint class projects.

6. **Attitudes**

   Encourage positive student attitudes towards role playing and in taking this activity very seriously because it will set the stage for much of what is to follow.

7. Remediation/Enrichment

A. Remediation: Have slower students work in groups with faster classmates.

B. Enrichment: Have several "high level challenge" tasks prepared for advanced students. Examples could include: establishing a stock offering, conducting a needs assessment, developing articles of incorporation, and the like.

8. Summary & Review

A. Organization of company
B. Development of finances
C. Organization of units
D. Operation/Management of a company

9. Review Questions & Answers *(Answers are in italics.)*

A. Name the three factors you must know to understand management.

1. *Functions of management* [M&P, T#13, 6, I]
2. *Levels of management*
3. *Managed areas of activity*

B. From the list below, choose the activities that are the functions of management.

1. *Planning (Setting goals and a course of action)* [M&P, T#13, 6, I]
2. *Identifying markets (Assigning tasks to certain jobs and establishing lines of authority)*
3. *Organizing (Assigning employees to jobs)*
4. *Directing (Supervising employes during their work)*
5. *Controlling (Comparing employee's work with the company plan)*
6. *All of the above.*

C. List five important areas of management activity. [M&P, T#13, 6, II]

1. *Research and development*
2. *Production*
3. *Marketing*
4. *Industrial relations*
5. *Financial affairs*

Date: ________ Class: ________________ Name: __________________

TAM #13 - Pre-test (Forming & Managing a Company)

Instructions: Circle the letter that corresponds to the correct answer.

1. The functions of management are: [M&P, T#13, 6, I]
    a. Directing
    b. Controlling
    c. Planning
    d. All of the above

2. The method of improving own products is: [M&P, T#13, 6, IV]
    a. Patent search
    b. Competitive analysis
    c. Technological development
    d. Comparison shopping

3. Directing is: [M&P, T#13, 6, III]
    a. The day-to-day operation of a business
    b. Ordering people to do things
    c. The establishment of policy
    d. All of the above

4. The steps in starting an enterprise are: [M&P, T#13, 6, I]
    a. Preliminary considerations
    b. Product availability
    c. Needs for the product
    d. Profit
    e. A and B
    f. A, B, and D
    g. All of the above

Date: ________ Class: ________________ Name: ________________

TAM #13 - Post-test (Forming & Managing a Company)

Instructions: The diagram below shows various levels of management. Please complete the diagram by inserting comparable position titles on the blank lines in the school and business columns: [M&P, T#13, 6, I]

1. Fill in the blanks.

School		Business
Title	Task/Function	Title
________________	Final Control	Stockholder
School Board	Form Policy	________________
________________	Day-to Day Control	President
Asst. Superintendent	Control of Major Function Area	________________
________________	Manages Single Facility	________________
Department Head	Manages an Area	Dept. Head
Teacher	Assigns and Supervises Workers	________________
________________	Does Work	Workers

(Adapted from Wright, 1985, p. 131)

Instructions: Circle the letter that corresponds to the correct answer.

2. A corporation is controlled by: [M&P, T#13, 6, I]
   a. The laws of the state where it is formed
   b. The corporate articles of incorporation
   c. The corporate bylaws
   d. All of the above

TAM #13 - Test Keys

TAM #13 - Pre-test answers

1. d   2. b   3. c   4. g

TAM #13 - Post-test answers

1. Fill in the blanks.

School		Business
Title	Task/Function	Title
Voter	Final Control	Stockholder
School Board	Form Policy	Board of Directors
Superintendent	Day-to Day Control	President
Asst. Superintendent	Control of Major Function Area	Vice-President
Principal	Manages Single Facility	Plant Manager
Department Head	Manages an Area	Dept. Head
Teacher	Assigns and Supervises Workers	Supervisors or Foremen
Student	Does Work	Workers

2. d

TAM #13: Forming & Managing a Company

Student Component

Introduction:

This activity will guide you through a study of the free enterprise system. This can be defined as a profit making organization which uses technology to supply goods or services to society. The purpose of this module is to have you set-up a manufacturing enterprise.

Competencies: Following the completion of this TAM, you will be able to:

1. Explain the fundamental characteristics, roles, structure and organization of the manufacturing and construction industry. [6,I]
2. Explain the steps and technology involved in major American applications of materials and processing technology. [6,III]
3. Apply standard industrial quality control procedures to items produced in the laboratory. [6,IV]
4. Solve materials and processing technology problems through problem solving, creative thinking and decision making processes. [6,V]
5. Relate the activities of manufacturing and construction technology to local, state, and national developments. [6,VI]

Module Overview:

This module contains one activity, namely the forming and managing of a manufacturing enterprise. In it, you will research, decide and document the decisions needed to establish a working business. Though this TAM contains much information, it will never be sufficient. Consult the Nelson & Selvidge textbook for additional detail and the forms useful in completing this activity.

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure
2. Complete the pre-test given by your instructor.
3. Do Activity #1 - Forming and managing a manufacturing enterprise.
4. Review and summarize what you have learned.
5. Complete post-assessment procedure.

Key Information:

1. **Class Presentations**

   - Forming a company
   - Managing a company

2. **Demonstrations**

   - Conducting an investigative meeting
   - Group planning and decision-making

3. **Safety**

   - Personnel safety requirements
   - Product safety
   - Manufacturer's liability

4. **Personal Activity**

   Before beginning work on these activities, it is recommended that you read any two of the following:

   Falk, R. F. (1976). Industrial enterprise. Madison, WI: Wisconsin Bureau for Vocational and Career Education, pp. 4-8

   Nelson R. & Selvidge, L. (1986). The manufacturing enterprise. Statesboro, GA: Southern University Press, pp.1-9, scan the rest.

   Wright, T. R. (1985). Exploring manufacturing. South Holland, iL: Goodheart-Wilcox. pp. 127-133

5. **Other**

   View additional films/videos such as the Phillips Petroleum series on American Enterprise.

Glossary:

Corporation	Legally created business, usually with many owners, who are called stockholders.
Industrial Relations	A process of operating programs to find, train and reward the company workforce.
Management	The accomplishment of goals through others.
Marketing	The process of identifying or finding people who will buy products. The process includes promotion, sales and distribution to the people.
Partnership	A business association of two or more persons.
Production	The process of making goods from material.
Proprietorship	A form of ownership by one person.
Research and Development	The processes of discovering, developing and specifying new and improved products.

Needed Materials:

1. **Supplies**
   - Pen/pencil
   - Paper
   - Eraser
   - Transparencies
2. **Equipment**
   - Chart pad and easel
3. **Handouts/Instructional Resources**
   - A. Student component of TAM #13

TAM #13: Forming & Managing a Company

Activity #1 - Manufacturing Enterprise: Plan of Procedure

This TAM will have you form a company and establish a means of managing it. To do this, you will need to establish corporate goals, to finance the company and then define activity areas which will need to be managed. These are areas of a company where specialized functions and sub-functions are carried out to operate the company and produce the goods or services. These areas are generally controlled by a management team member.

First, you are to form a team and establish the corporate goals and financial foundation of your company. Your next challenges are to develop the management plan and structure for the company. **Document your results in a three-ring binder that keeps them neatly organized.**

Begin by considering the activity areas generally found in manufacturing companies.† These include:

1. Corporate goals: Establish a set of corporate goals. Answer the questions: What will this company do and why? Document your answer in a half-page statement.
2. Company Organization: Decide upon and document the structural organization. This is the mechanism by which a company produces goods or services or income for profit to the owner(s). Generally organizations have structures which depict department, units and their hierarchy. Each unit has functions and sub-functions.
   A. In trying to organize a company, you should use the following procedures:
      1. Preliminary considerations
      2. Availability of product to produce
      3. Need for the product
      4. Profit

TECH-PRO CORP.

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†The project team appreciatively acknowledges Rex Nelson's cooperation in permitting adaption of material from the book; Nelson R. & Selvidge, L. (1986). The manufacturing enterprise. Statesboro, GA: Southern University Press.

B. In selecting the type of enterprise to form, you should consider three alternative forms of ownership:
    1. Sole Proprietorship
    2. Partnership
    3. Corporation

C. To establish proper financing, consider the following:
    1. Personal funds
    2. Borrowing
    3. Bonds
    4. Stocks
    5. Holding companies

3. **Company Management:** This is where the company personnel who are responsible for the total successful operation of the company and the specialty areas within the company work to accomplish the corporate goals.

A. Typically this involves detailing of each corporate goal:
    1. Analyzing what it means
    2. Establishing timelines
    3. Developing a detailed course of action

B. Then you direct the attainment of objectives by:
    1. Organizing facilities personnel and resources
    2. Communicating the course of action
    3. Motivating others
    4. Directing, guiding or counseling for progress

C. You measure the results by:
    1. Taking measurements/collecting data
    2. Evaluating your findings

D. You develop people by:
    1. Identifying qualified people
    2. Promoting qualified people
    3. Training qualified people
    4. Insuring continuity of qualified people

E. Finally, you promote innovations using:
    1. Product innovation
    2. Methods and process innovation
    3. Market innovations
    4. Innovative use of finances

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4. **Systems Analysis:** This step involves the development of management information systems. These will prepare and collect timely information and make it accessible to help in quick identification, recording, analysis, solution and manipulation of problems relating to your enterprise.

5. **Research and Development**: Here you apply the processes, operations and techniques of science and technology to produce products, processes and services which should benefit the organization. The functions and sub-functions are:

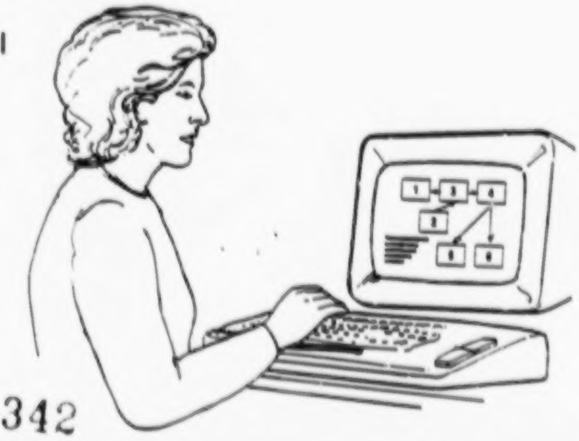
   A. Research: There are two types that can be used:
      1. Basic research
      2. Applied research

   B. The development phases consist of the following:
      1. Advanced product improvement
      2. New product development
      3. New process development and process improvement
      4. Product redevelopment for cost reduction

   C. Product engineering is the final phase of research and development. In this phase, you implement the following:
      1. Product design
      2. Engineering test
      3. Factory follow-up
      4. Sales assistance

6. **Production:** This is the area where you develop the most economical processes and plans for producing researched and developed products; coordinate the required human resources; secure and coordinate materials, facilities, tools and utilities; make products and direct them to the customer.

   A. Production consists of the following:
      1. Plant engineering
      2. Utilities design and operations
      3. Facilities design and specific operations
      4. Maintenance
      5. Plant equipment and control



B. Industrial engineering, involves:
   1. Methods of study
   2. Plant layout
   3. Work measurement
   4. Materials handling and study
   5. Tools, jigs, fixtures and pattern manufacture and repair

C. During purchasing, you consider:
   1. Buying
   2. Purchase expediting
   3. Purchase records and files
   4. Purchase research
   5. Salvage sales

D. During the production planning and control phases, you must review:
   1. Traffic
   2. Factory receiving
   3. Factory shipping
   4. Materials procurement
   5. Operation scheduling
   6. Tool, jig, fixture and gage procurement
   7. Production instruction distribution
   8. Dispatching
   9. Production expediting
   10. Performance reporting
   11. Storekeeping
   12. Stores control

E. During the manufacturing phase, you must consider the following:
   1. Processes of manufacturing
   2. Subassembly during manufacturing
   3. Service and repair

F. The quality control stage requires that you consider:
   1. Statistical methods of control
   2. Gage control
   3. Test and inspection procedures
   4. Customer complaints
   5. Salvage

7. **Marketing:** Marketing is the management area in which you direct and encourage the flow of products from the producer to consumers.

A. In marketing research, you must consider:
  1. Market analysis
  2. Product requirements determination
  3. Distribution problem analysis

B. In advertising, you must plan your:
  1. Campaign strategies
  2. Copy preparation
  3. Media selection
  4. Advertising production

C. During the sales promotion stage, you must develop:
  1. A program
  2. Sales aids

D. While in the sales planning phase, you must consider:
  1. Sales policies determination
  2. Budgeting
  3. Pricing
  4. Buying
  5. Packaging

E. Then in sales operations, you must plan your:
  1. Salesperson hiring
  2. Salesperson training
  3. Salesperson direction
  4. Salesperson computerization
  5. Order service
  6. Selling policy

F. In physical distribution, you must consider your:
  1. Warehousing
  2. Shipping
  3. Product service

8. **Finance and Control:** Here you plan, direct and measure the results of company monetary operations.

   A. In finance operations, you implement the following:
      1. Financial planning
      2. Tax management
      3. Financial relations
      4. Custody of funds
      5. Credit and collections
      6. Insurance

   B. In the controlling phase, you must establish the following procedures:
      1. General accounting
      2. Cost accounting
      3. Planning and budgeting
      4. Internal auditing
      5. Systems and procedures

9. **Personnel Administration:** Here you develop and administer policies and programs for providing an effective system structure, qualified workers, equitable treatment, advancement opportunities, job satisfaction and adequate job security. The functions and sub-functions are:

   A. Employment; here you coordinate:
      1. Recruitment
      2. Selection
      3. Induction
      4. Promotion and transfer
      5. Separation

   B. In wage and salary administration, you consider:
      1. Employee classification
      2. Rate determination
      3. Merit ratings
      4. Supplemental compensation
      5. Work schedule control

   C. In industrial relations, you organize:
      1. Communications
      2. Collective bargaining
      3. Employee discipline
      4. Personnel research

D. In organization planning and development, you establish:
    1. Organization planning
    2. Human resource development
    3. Training

E. In employee services, you develop:
    1. Medical services
    2. Recreation
    3. Personnel services
    4. Safety
    5. Protection and security

10. **External Relations:** You plan and coordinate relationships of the company's representatives with all or selected elements of the public in order to achieve acceptance of the company, its objectives, its personnel and its conduct. The functions and sub-functions are:

A. In communications and information, you coordinate:
    1. Attitude and opinion appraisal
    2. Public communications
    3. Employee information exchange
    4. Creditor and investor communications

B. In public activities coordination, you plan:
    1. Civic affairs participation
    2. Association and society relations

11. **Secretarial and Legal:** This includes duties, as required by law, appraising and advising the corporation on all matters of its operations and relations from a legal point of view.

A. In the secretarial area, you must consider:
    1. Stockholder affairs
    2. Board of directors affairs
    3. Corporate affairs

B. In legal matters, you must develop:
    1. Corporate affairs
    2. Employee affairs
    3. Financial affairs
    4. Patent affairs

TAM #13 - Summary

1. **Review and Summary Activities**

   This TAM's activity introduced you to the founding, organization and management of a company. Although there are many variations possible, the content was chosen to be representative of the world of work.

   Once you have learned the principles, practices and functions of manufacturing management you should be able to establish and operate a manufacturing enterprise. Therefore, the knowledge and experience learned in this TAM will be very useful to you now and in the future.

2. **Review Questions -- Test Yourself**

   A. Describe the organizational title (position and corporate responsibilities) of each of the following:

      1. Assembly line worker
      2. Automotive mechanic
      3. Computer programmer
      4. Chemical engineer
      5. Company president
      6. Designer
      7. Machinist

   B. Describe the coordination role of management.

   C. Explain how top management should "control" the work of the training department.

TAM #13 - Post-assessment

Instructions:

1. Complete the self-check on your company's binder by insuring that each of the plan of procedure's eleven content areas is addressed in some clear way. In your binder, you should have a heading for each major section.

2. Have the instructor complete an evaluation of your binder as a group project. Discuss his/her assessments.

3. Complete the post-test for TAM #13.

4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	Introduction to Materials and Processing Technology

Technology Activity Module #14

Career Development

YOUR CAREER
Occupational Outlook Handbook

TAM #14: Career Development

Instructor Component

Activity Objective: The main purpose of this activity is to help the student explore the various careers, occupations and job fields, particularly those found within materials and processing technology, e.g., manufacturing and construction. Students will use a self-assessment process that is supported and guided by the strategies incorporated into the SIGI-Plus, MO-View or equivalent guidance system.

Activity Competencies: By completing this TAM, the student will be able to:

1. Demonstrate informed and meaningful occupational and educational choices. [7,I]
2. Explore career choices in engineering and related technological areas. [7,I]
3. Assess his/her personal characteristics, talents and interests as they relate to a career in materials and processing technology. [7,II,A]
4. Demonstrate appropriate employability skills in job identification, seeking and application. [7,III]
5. Demonstrate personal characteristics, interpersonal relations, dependability, work attitude, communication ability, personal hygiene/grooming appropriate to employability. [7,III]
6. Express a positive attitude regarding equipment, productive effort and safety for him/herself and others. [7,III]
7. Differentiate among various career roles, levels and functions in materials and processing technology. [7,IV]
8. Identify and classify occupations in the materials and processing technology industry. [7,IV]
9. Identify and describe career and technological trends in materials and processing technology. [7,V]
10. Identify preparatory routes that lead to tentative career choices. [7,VI]
11. Describe the various levels of education available for preparation for careers in technology. [7,VI]
12. Describe the potential for entrepreneurial activity in materials and processing technology. [7,VII]
13. Research and describe occupational prospects of various materials and processing technology. [7,VIII]

Module Instructions

Introduction:

This module guides students through an exploration of the world of work and it helps them familiarize themselves with many occupational fields. A self-assessment component identifies relative strengths and weaknesses to further contribute to more informed career decision-making. This module can be incorporated into normal classroom activities. The activities in this module include pre- and post-tests, demonstration of procedures, self-assessment and career planning.

Needed Materials:

1. **Supplies**

   - SIGI-Plus and/or
   - MO-View and/or
   - Other guidance information system.

2. **Equipment**

   - MO-View fiche viewer
   - Microcomputer compatible with Micro-View, SIGI-Plus or other guidance information system

3. **Handouts**

   A. Student component of TAM #14
   B. Occupational Cluster Description Handout
   C. MO-View Career Deck Components

4. **Instructional Resources**

   A. Film (discuss available career guidance films with your schools guidance counselor and select an appropriate title)

   B. Books and Articles

   Career Planning and Placement Center. (1986). CPPC information series #73. Columbia, MO: University of Missouri-Columbia.

   Educational Testing Service. (1985). SIGI-Plus: A guide to further resources. Princeton, NJ: ETS. pp. 2-15.

   Holland, L. J. (1985). The occupations finder. Odessa, FL: Psychological Assessment Resources.

   Holland, L. J. (1985). The self-directed search: A guide to educational and vocational planning. Odessa, FL: Psychological Assessment Resources. pp. 1-14.

U.S. Dept. of Labor. (1989). Occupational outlook handbook. Washington, DC: Bureau of Labor Statistics, U.S. Dept. of Labor.

U.S. Dept. of Labor. (1986). Dictionary of occupational titles. Washington, DC: Bureau of Labor Statistics, U.S. Dept. of Labor.

Vare, E. A. (1989). Mothers of invention. New York: Quill.

C. A guest lecturer such as the school's guidance counselor

Management/Logistics:

1. **Related TAMS: None**

2. **Evaluation/Grading**

   It is suggested, due to the importance of career development as an overall outcome of schooling, that the instructor weight heavily the activity aspects of this TAM, particularly the SIGI-Plus and MO-View portions.

3. **Suggested Schedule/Time**

   The suggested time for this TAM is one week when it is the primary focus of the students' work. If the TAM is assigned as a distributed unit, i.e., an activity to be completed during other activities in the course, a three to four week period would be appropriate.

Key Instructional Suggestions:

1. **Safety**

   No special precautions apply other than securing appropriate permissions for student field trips and job shadowing experiences.

2. **Motivation**

   Schedule a field trip to a local manufacturing plant or construction site and analyze the range of occupations in terms of levels and responsibilities. Participate in a local career fair as an alternative.

3. **Prerequisite Information**

   None

4. **Demonstrations**

   Arrange for the school's counselor to demonstrate SIGI-Plus and/or MO-View using a question format that is interesting to students, e.g., "If you knew you wanted to become a construction superintendent, how would you prepare?", etc.

5. Reinforcement

Select a motivational film/video that shows how key successful people have "made it." The guidance office will have lists of such materials. Alternatively or additionally show a film/video describing the key phases and activities in the career development process.

6. Attitudes

Encourage students to take the activities in this TAM seriously. They are a vehicle for learning both the career development process and the results of that process. Indicate that the average person uses this process several times during his/her life and that with advances in technology, career changes are likely to increase in frequency.

7. Remediation/Enrichment

A. Remediation: Slower students should be paired with faster, but considerate, ones and their activities carefully monitored to help them develop.

B. Enrichment: Faster students should be afforded the opportunity to examine their tentative career choice in-depth, perhaps by a shadowing experience wherein they follow a person in their chosen field for a day or week. Be sure to challenge faster students to insure that they do not settle for too little!

8. Summary & Review

A. What is the career development process?
B. What can SIGI-Plus be used for?
C. What are the major components of MO-View?

9. **Review Questions & Answers** *(Answers are in italics)*

A. What are four important reasons why one needs an accurate understanding of one's skills before making career choices?

1. *A knowledge of your strongest skills can help you make career choices that best match your abilities.*
2. *A knowledge of your weakest skills can help you avoid career mismatches in fields that may be inappropriate for you.*
3. *A clear understanding of your skills can assist you in writing an effective resume or application, plus can give you self-confidence and information to use in your job interviews.*
4. *Being aware of your weaker skills can highlight areas in which you may want to gain additional training or experience if those skills are needed to accomplish your career goals.*

B. How can one validate a tentative career choice?

1. *By checking with one's parents and friends*
2. *By shadowing a person working in your tentative career choice*
3. *Confirming the choice with a guidance counselor and/or teacher*
4. *By working part-time in or around the occupation*

C. List three reasons for using the SIGI-Plus or other career information system.

1. *It provides multiple levels and perspectives of guidance input.*
2. *It allows the opportunity to explore while also providing a guide.*
3. *It is easy and fun.*

D. What can the MO-View system best provide?

1. *It gives specific career information valid for Missouri.*
2. *It provides input about the preparation needed for certain careers.*
3. *It is self-guided and up-to-date.*

TAM #14 - Test Keys

TAM #14 - Pre-test answers

There is no key possible since the a self-assessment process is used here.

TAM #14 - Post-test answers

There is no key possible since the a self-assessment process is used here.

Date: ______ **Class:** ____________________ **Name:** ____________________

TAM #14 - Pre-test (Career Development)

Instructions:

1. List, on lines a-h below, the occupations you have considered in thinking about your future. List careers/jobs you have daydreamed about as well as those you have discussed with others. Try to show the history of your tentative choices and daydreams by putting your most recent choice on Line a and then work backwards to the earlier jobs you have considered. Note, you do not have to fill all the lines. Leave the Code columns blank for now.

Occupation		Code	
a. ____________________	☐	☐	☐
b. ____________________	☐	☐	☐
c. ____________________	☐	☐	☐
d. ____________________	☐	☐	☐
e. ____________________	☐	☐	☐
f. ____________________	☐	☐	☐
g. ____________________	☐	☐	☐
h. ____________________	☐	☐	☐

2. Arrange to visit the guidance office and/or get a copy of the school's recommended self-assessment procedure. Holland's (1986) The self-directed search is an excellent example. Use the guide to identify the code for each occupation (above).

3. Work through the guide's recommended procedures and summarize by listing your:

   A. Greatest strength: ____________________

   ____

   ____

   B. Main weakness: ____________________

   ____

   ____

4. Using the Dictionary of occupational titles, or other career descriptive listing such as SIGI-Plus, MO-View, or Micro-View; identify three jobs that capitalize on your strengths and for which your weaknesses are of little importance. Write the job titles on lines A - C. (leave the box blank at this time)

   A. ____________________________________ ☐

   B. ____________________________________ ☐

   C. ____________________________________ ☐

5. Consult a career information source such as the Occupational outlook handbook and look up each of the jobs you identified in step 4. Classify the employment possibility projections (future) for each job as being either excellent, good/average, or poor and write this into the box at the end of that job's line in step 4 (above).

6. Review all the information you recorded during steps 1 - 5 and consider your overall interests and characteristics. Given all this, tentatively identify two jobs that you would be interested in doing for the first part of your life after your schooling is finished. List these two jobs below:

   A. ______________________________

   B. ______________________________

Date: ______ **Class:** ____________________ **Name:** ________________

TAM #14 - Post-test: Career Assessment Checklist (Career Development)

Instructions:

1. Summarize the evidence that documents your performance of each of the activities listed below. List it and also check off the appropriate column.

   A. Visited guidance office and learned what resources were available. | Yes | No |

   Evidence: ________________________________
   ____

   B. Discussed career futures with a teacher, counselor, parent or other adult. | Yes | No |

   Evidence: ________________________________

   C. Completed a self-assessment to identify: | Yes | No |
   - career interests
   - personal strengths
   - weaknesses

   Evidence: ________________________________
   ____

   D. Identified target jobs of interest. | Yes | No |

   Evidence: ________________________________
   ____

   E. Assessed occupational/technological trends of target jobs. | Yes | No |

   Evidence: ________________________________

   F. Observed/shadowed a person in one of the target jobs (half-day minimum) | Yes | No |

   Evidence: ________________________________

   G. Identified preparation/training necessary to enter target job. | Yes | No |

   Evidence: ________________________________
   ____

2. Have your instructor review the above and answer any questions that you might have. | Yes | No |

   Evidence: ________________________________
   ____

3. Plan out the logical "next steps" for you to progress towards the job target you have identified. Concentrate on those that need to be done in the next five years.

   A. ________________________________
   B. ________________________________
   C. ________________________________

TAM #14: Career Development

Student Component

Introduction:

Your future will involve continued rapid change in the world of work and technology. Technological modernization and other factors are modifying what you will do at work, how and where you work and in many cases how long you continue doing whatever you are going to do. The changing world of work makes your choice of an occupation more difficult and probably more frequent. Therefore, career development information and processing has become more important than ever to you and to everyone you know!

The purpose of this TAM is to teach you the foundations of career development, its information sources, its organization and how it can be used, so that you can better:

1. Understand how people relate to work, how the world of work is structured, what materials describing work exist and how they can be organized and applied.
2. Organize career materials in meaningful and useful ways.
3. Apply career materials with individuals and with groups in ways that enhance career development.

Competencies: Following the completion of this TAM, you will be able to:

1. Demonstrate informed and meaningful occupational and educational choices. [7,I]
2. Explore career choices in engineering and related technological areas. [7,I]
3. Assess his/her personal characteristics, talents and interests as they relate to a career in materials and processing technology. [7,II,A]
4. Demonstrate appropriate employability skills in job identification, seeking and application. [7,III]
5. Demonstrate personal characteristics, interpersonal relations, dependability, work attitude, communication ability, personal hygiene/grooming appropriate to employability. [7,III]
6. Express a positive attitude regarding equipment, productive effort and safety for him/herself and others. [7,III]
7. Differentiate among various career roles, levels and functions in materials and processing technology. [7,IV]
8. Identify and classify occupations in the materials and processing technology industry. [7,IV]
9. Identify and describe career and technological trends in materials and processing technology. [7,V]
10. Identify preparatory routes that lead to tentative career choices. [7,VI]

11. Describe the various levels of education available for preparation for careers in technology. [7,VI]
12. Describe the potential for entrepreneurial activity in materials and processing technology. [7,VII]
13. Research and describe occupational prospects of various materials and processing technology. [7,VIII]

Module Overview:

This module contains two activities. They are:

1. Walking through the career decision-making process
2. A. Using MO-View
   B. Using SIGI-Plus

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.

2. Complete the pre-test given by your instructor.

3. Do Activity #1 -- Walking through the career decision-making process.

4. Use Activity #2A or #2B as necessary to help accomplish Activity #1.
   -- Using MO-View
   -- Using SIGI-Plus

5. Review and summarize.

6. Complete post-assessment procedure.

Key Information:

1. **Class Presentations**

   •Using SIGI-Plus
   •Using MO-View

2. **Demonstrations**

   •Walking through the career decision-making process
   •How to use MO-View

3. **Safety**

   Secure instructor and parent permission prior to job shadowing.

4. Personal Activity

Before beginning work on these activities it is recommended that you read/scan the following as appropriate:

Educational Testing Service. (1985). SIGI-Plus: A guide to further resources. Princeton, NJ: ETS. pp. 2-15.

Holland, L. J. (1985). The self-directed search. Odessa, FL: Psychological Assessment Resources.

U.S. Dept. of Labor. (1989). Occupational outlook handbook. Washington, DC: Bureau of Labor Statistics, U.S. Dept. of Labor.

5. Other

Additional information will be provided to you by video presentation and/or instructor discussions.

Glossary:

Awareness	The career development stage at which an individual begins to realize that many different career paths are available, offering him/her different opportunities and imposing different demands.
Career	The totality of work one does in his/her lifetime.
Career Counseling	A one-to-one or small group relationship between a client and a counselor with the goal of helping the client(s) integrate and apply understanding of self and the environment to make the most appropriate career decisions and adjustments.
Career Development	The process of increasing career maturity by sequencing through the stages of awareness ==> exploration ==> preparation.
Career Information	Knowledge related to the world of work that can be useful in the process of career development.
Decision-making	The career development stage at which the individual applies the information accumulated about jobs to the information about self and begins to formulate tentative dreams for the future.
Employment	The actual entrance into the world of work.
Exploration	The career development stage at which the individual becomes more knowledgeable and gains understanding of the common and unique characteristics of occupations and of people.
Preparation	The career development stage at which the individual begins to act on tentative career plans by choosing subjects or experiences that are related to job performance.
Work	An activity that produces something of value for other people.

Needed Materials:

1. **Supplies**
   - SIGI-Plus and/or
   - MO-View and/or
   - Other guidance information system.

2. **Equipment**
   - MO-View fiche viewer
   - Microcomputer compatible with Micro-View, SIGI-Plus or other guidance information system

3. **Handouts**

   A. Student component of TAM #14
   B. Occupational Cluster Description Handout
   C. MO-View Career Deck Components

TAM #14: Career Development

Activity #1 - Walking Through the Career Decision-making Process†: Plan of Procedure

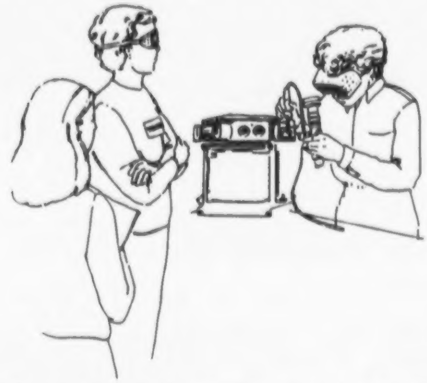
There are eight key steps to career decision-making. Following each carefully will help you in making an informed career decision that maximizes your potential for reward and satisfaction. Use the guidance office or instructor-supplied materials, or a system such as SIGI-Plus or MO-View and do each of the following steps carefully! Record the results in the space provided under each step.

1. Self-Assessment:................................... **[What do I want? What am I good at?]**

   This is the beginning stage of the search in which you discover your abilities, interests and values in relation to an occupation. In doing so you should:
   - Look at your values and decide what is most important to you.
   - Choose the main interest fields you want to use in your work.
   - Choose work activities you like and can do well.

2. Search:.. **[What occupation might I like?]**

   This step involves the entire process of pulling together your abilities, skills and values in order to find an ideal work environment. It also involves finding out about the world of work. In doing so you should:
   - Choose features you want in your work.
   - Choose features you want to avoid in your work.
   - Create a list of occupations that match what you like.



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†Based on the process incorporated in the SIGI-Plus system by Educational Testing Service. See activity #2B.

3. Information:.. **[What Occupations might I like?]**

Now you will engage in the process of researching your ideal career choices. **First, review your responses to questions 1 & 2 above, and also your pre-test answers, then choose the two occupations you would like the most. Answer the following specific questions about your top occupation in a written page and attach it to this TAM**:

- What skills does this occupation require?
- What are the possibilities for advancement in this field?
- What is the potential income in this field?
- What is the national employment outlook in this field?
- What are the educational requirements?

____

____

____

4. Skills:... **[What can I do well?]**

This is an analysis of your strengths and weaknesses, and the personal skills required, work environment, preparation needs and rewards of various occupations. For more details, refer to:

- Specific skills required for any occupations in MO-View or SIGI-Plus
- Rate yourself on these skills.

____

____

____

5. Preparing: .... **[Can I do what is required?]**

This is a requirement or preparation for fulfilling your career choice. To begin this important process, **complete questions 1 -4 of this activity**. Also, you can:

- See typical preparation paths to any occupation in SIGI-Plus.
- Estimate your chances of completing any further preparation you need.

____

____

____

6. Coping:................................**[Can I overcome problems that I might encounter?]**

This step involves developing strategies of how to deal with the problems that you may face while pursuing a particular career choice. It is recommended that you:

- Get suggestions for dealing with issues related to preparing for a career, e.g., finding time and money, arranging care for others and obtaining academic credit for what you already know.
- Learn to develop strategies for handling problems common in a college or training situation.

7. Deciding:...**[What is right for me?]**

At last, the most important step! Decisions, decisions! **Complete question 5 and 6 first.** Now you must decide by choosing the career choices which will benefit, and fit, you most. Confirm your decisions by asking yourself the following questions:

- What are the rewards? Will I enjoy this occupation?
- What are my chances? Can I get in?
- All in all, would this be a good choice for me?
- Do you think that in three years your answers will be the same?

8. Next steps:...**[How do I put my plan into action?]**

But deciding is not enough. Wishing won't make your career come true. Most careers require you to take specific action. Continue moving toward your career goal by planning short-term goals such as:

- Getting education or training
- Developing skills required
- Proving you can do the work
- Building a network of "contacts"
- Writing resume
- Overcoming obstacles

My Career Plan

Step	Description of action needed	Date to be accomplished by
1		
2		
3		
4		
5		
6		

TAM #14: Career Development

Activity #2A - Using MO-View: Plan of Procedure

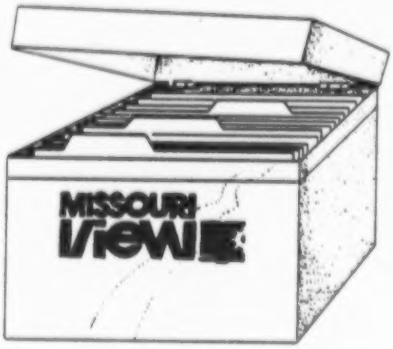
Overview:

MO-View is a career decision-making system that will help you in selecting potential career fields based on your likes, dislikes, strengths and weaknesses. Also, it can help you select careers that are not traditional. The system is designed to provide current information on occupations and training school programs in Missouri. It has three important parts:

1. Microfiche reader.

2. A deck of microfiche cards, organized into a career deck and a school/training program deck. The careers are arranged alphabetically and organized into fifteen occupational clusters.

   Generally, jobs and school titles are found in the upper left corner of the cards. On the school/training program cards, colleges & universities, community & junior colleges and area vocational schools are listed which provide specific preparation for certain jobs.



3. An index which helps you in finding each job and school card from the deck. In locating any occupation or school program, look for the occupation or the school in the index, then go to the deck and locate the card with the corresponding title.

Plan of Procedure:

Listed below are some steps you could follow in using MO-View to gain insight into your career aspirations and opportunities. Prepare a report to your instructor, or incorporate your findings and decisions in your responses to Activity #1, that lists each numbered heading neatly. Under each heading, describe what you did and/or decided using the bulleted points as a guide.

1. Introduction
    - Special keys
    - What can you do in each section?
    - A recommended approach
2. Assessment of one's self
    - Summary of values
    - How did you weight your values?
    - What fields interest you?
    - Your most important activities
3. Choosing an occupation
    - List occupations/features asked for
    - Why is an occupation not on the list?
4. Occupational information
    - Definition of occupations
    - Description of work activities
    - Job titles
    - Skills required
    - Education required
5. Required skills
    - Summary of skills
    - What you said to yourself
6. Preparing for an occupation
    - Overview of how to prepare
    - Formal education or training
    - Learning by doing
    - Chances of preparing
    - Summary of chances
7. Planning a future
    - Record of time used
    - The 4-step method to estimate total preparation
8. Decision making
    - Where occupations showed up on your decision square in the MO-View guide.
9. What are my next steps?
    - Overview of how to prepare
    - Skills required
    - Building network of contacts
10. Turn in your career report to the instructor

TAM #14: Occupational Cluster Description Handout

1. Agri-business and Natural Resources
   This cluster is made up of jobs concerned with producing and processing materials for use as feed, clothing, offices and homes. These materials may also provide energy to run machinery and heat homes and factories.

2. Business and Office
   Jobs in this cluster deal with all aspects of running an office or business; keeping records, using different machines and equipment, and managing workers.

3. Communications and Media
   Careers in this cluster are related to the sharing of ideas and information. Media include any tools or devices used for this purpose. Newspapers, magazines, radio, television, telephone and telegraph are the major media of communications.

4. Construction
   The construction cluster careers are those in the building industry. Construction jobs include those nvolved in building such things as homes, offices and other buildings, roads, bridges, airports and dams.

5. Consumer and Homemaking Education
   This cluster of jobs includes those jobs whose aim is to teach the skills necessary to run a home -- like preparing food and making clothes. In addition to these there are jobs which help people make the most of the many different household products, equipment and services they can use.

6. Environment
   The jobs in this cluster deal with protecting our natural resources and keeping the air and water of our environment clean to protect people's health. Most of these jobs have been developed during the past 15 years.

7. Fine Art and Humanities
   The fine art and humanities cluster includes jobs that involve ideas and feelings. These are expressed by written and spoken words. Other materials used for expression include cloth, paper, paint, ink, concrete and so on. Some jobs express ideas and feelings through performances in dance, drama or music.

8. Health
   Jobs in this cluster deal with keeping healthy people from becoming ill and treating those who are ill to make them healthy again.

9. Hospitality and Recreation
   These careers help people plan and make use of their time off from work. Hospitality-type jobs are those in which people plan trips and provide transportation, while recreational type jobs are those dealing with amusement and entertainment.

10. Manufacturing
Jobs in the manufacturing cluster involve the processing of goods by machine or by hand. These products may be large or small and are produced in quantities that range from many to a very few of certain items.

11. Marine Science
This cluster of jobs deals with obtaining food and minerals from fresh and ocean waters. Some of these jobs deal with researching ways to use resources in lakes, rivers and seas, while others deal with designing and constructing structures people need below and on the surface of the water.

12. Marketing and Distribution
Jobs in this cluster are the link between the producer and the consumer. Some necessary abilities in this field are: artistic talent, writing skills, physical stamina and the ability to get along well with others.

13. Personal Services
Personal services jobs help people live a better life. Making life more comfortable for others is the duty in some of these jobs, while others deal with making people more attractive. To do this type of work, one must enjoy doing things for others and be able to get along well with them.

14. Public Service
Helping people is the theme of all jobs in this cluster. You must be able to work with people and understand their needs, problems and concerns. You must be able to talk with people and make them feel at ease and have a real desire to make the world a better place to live.

15. Transportation
Different ways of moving people and goods from place to place describes the transportation cluster. Any job related to this is included, from selling tickets to driving a truck, planning a route or unloading a ship.

(Adapted from MO-View, 1984-85, pp. 10 -11)

TAM #14: Career Deck Component Handout

1. Job Title: Found in D.O.T.

2. D.O.T.: Dictionary of Occupational Titles nine digit classification number xxx-yyy-zzz

3. Cluster No. USOE Training Number Holland's Occupational Classification - 3 Letter Code

4. The Job
A basic description of the job duty is given. Pertinent questions are asked for the purpose of providing structure to the student and to serve as stimulation for the data-gathering process.

5. To Get The Job
Four categories deal with aptitudes, interests, physical demands, miscellaneous requirements and other related comments. More information and further explanation pertaining to this job is found on Page Two, entitled "On the Job."

6. Things to Think About
Additional in-depth comments are explored including advantages, disadvantages, chances of advancement, fringe benefits and related occupations.

7. On the Job Description and Specific Job Duties
These are given but they may vary with the employer.

8. Earnings
It should be understood that some of the information will vary with the employers. The average starting salary and the salary range is listed for the St. Louis metropolitan area. In most cases, the forty-hour week is in effect.

9. Employment Opportunities
This section gives a student an opportunity to learn what the employment potential is for the various metropolitan areas. The Missouri View report provides specific data regarding net growth and replacement for a six-year period. This information should help a student judge whether or not to enter this field of occupational training.

10. Preparation and Training
The general level of education needed, helpful high school subjects and a list of schools offering training are listed. The school courses related to the training should be beneficial in that a student may realize some subjects are too difficult and, therefore, wish to choose another occupation. If students have access to this information early, they can prepare for the occupational training in advance. The training programs will include high schools, area vocational - technical schools and institutions offering training in the occupation for your region. Occasionally, an institution outside the region will be listed.

11. Where to Get More Information
The names and addresses of both regional and national sources are listed. A student can write for brochures, pamphlets and other information. The student is always referred to the counselor with the hope that this may initiate a commitment to the decision-making process.

(MO-View, 1984-85, pp. 102-105)

TAM #14: Career Development

Activity #2B - Using SIGI-Plus: Plan of Procedure

This activity involves using the computerized guidance information system called SIGI-Plus. If this is available follow these steps, otherwise refer to this TAM's Activity 1.

Early in your time in front of the SIGI-Plus computer, it will present you with a screen that asks what you want to do. The choices are:

(1) I really don't know what I want to do.
(2) I'm in school and I'm trying to decide what to study.
(3) I have an occupation in mind and I want to know more about it.
(4) I want to find an occupation that uses the skills and experience I already have.
(5) I'm just curious about SIGI-Plus.
(0) None of the above.

Using these commands, work through the career development process by answering the following questions.

1. Self Assessment: .... [What do I want? What am I good at?]
   This is the beginning stage of the search in which you discover your abilities, interests and values in relation to an occupation.
2. Search: .... [What occupation might I like?]
   This step involves the entire process of pulling together your abilities, skills and values in order to find an ideal work environment. It also involves finding out about the world of work.
3. Information: .... [What Occupations might I like?]
   Now you will research your ideal career choice.
4. Skills: .... [What can I do well?]
   This is an analysis of the strengths, personal skills required, work environment, preparation needs and rewards and general weaknesses of your capabilities.
5. Preparing: .... [Can I do what is required?]
   This results in an estimate of your chances for completing preparation and other requirements.
6. Coping: .... [Can I do what is required?]
   This step involves developing strategies of how to deal with the problems that you may face while pursuing a particular career choice.
7. Deciding: .... [What is right for me?]
   At last, the most important step! Decisions, decisions! Now you must decide by choosing between the top career choices which will benefit you most.
8. Next steps: .... [How do I put my plan into action?]
   But deciding is not enough. Wishing won't make your career come true. Most careers require you to take specific action. Now work toward your career goal by identifying short-term goals.

TAM #14 - Summary

1. **Review & Summary Activities**

   Career development tends to blend into all aspects of your education and work from now on. The purpose of this TAM is to help you know yourself and through this, to help you make better plans and to increase your experience in self-assessment.

2. **Review Questions – Test yourself!**

   A. There are eight "key steps" involved in career development. Describe each.

   B. What are the three essential "phases" in career development?

TAM #14 - Post-assessment

Instructions:

1. Have the instructor review your work and discuss questions that remain.
2. Complete the post-test for TAM #14.
3. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Course:	**Introduction to Materials and Processing Technology**

Technology Activity Module 15

Leadership Development

TAM 15: Leadership Development

Instructor Component

Activity Objective: The purpose of this TAM is to develop four of the key component skills required for group and individual leadership. The more proficient a student is with these skills, the better he or she will be able to operate in industrial technology classes, at work and even in their personal lives. Students will encounter and practice communications, effective delegation, project planning and analysis, and management skills. Simulations, role-playing, and group projects are the means used to accomplish goal achievement.

Activity Competencies: By completing this TAM, the student will be able to:

1. Identify characteristics necessary for leadership in technology. [8,I]
2. Identify the leadership quality characteristics of both present and past leaders in technology. [8,I]
3. Describe and illustrate qualities contributing to effective leadership. [8,II]
4. Demonstrate leadership in individual activity related to the course. [8,II]
5. Employ leadership skills in performing officer duties and guiding student organization activity. [8,III]
6. Work cooperatively with others in leader and follower roles. [8,III]
7. Bring group activity to a successful conclusion. [8,IV]
8. Participate effectively in local, state and/or national clubs. [8,IV]

Module Instructions

Introduction:

This activity is designed to have students practice some of the essential skills necessary to effective leadership. Although they are presented separately, obviously in the real world all of these component skills blend into one. Therefore, it is recommended that the ITE instructor attempt to create a setting wherein the students also can practice/apply these skills in an integrated manner.

Safety Considerations:

Minimally applicable

Needed Materials:

1. **Supplies**
   - Note paper
   - Felt pens
2. **Equipment**
   - Chart pad and easel
3. **Handouts**
   A. Student component of TAM #15
4. **Instructional Resources**
   A. Film (select one from the many various motivational/business film services)

   B. Books and Articles

   Pfeiffer, J. (ed.). (1988). The annual: Developing human resources. San Diego, CA: University Associates.

   C. A guest lecturer. For example, pick a local leader from any aspect of the community -- the characteristics of leadership are the same.

Management/Logistics:

1. **Related TAMS:** TAM #13 Forming & Managing a Company
2. **Evaluation/Grading**

   It is suggested that the instructor observe each student and report the results to him/her four times a semester. It is the students' performance that should generate the grade.

3. **Suggested Schedule/Time**

   This activity could be compressed into one week but two to three weeks would be more appropriate, however, this does not need to be consecutive.

Key Instructional Suggestions:

1. **Safety**

   Minimally applicable given the nature of this activity.

2. **Motivation**

   It is important that the instructor work to establish perceived value in the students. Point out that the skills learned via this activity will contribute to success in the annual MITEA Industrial Technology Exposition and Contest.

3. Prerequisite Information

None

4. Demonstrations

- Act out some non-verbal communication "messages"
- Role play key leadership styles

5. Reinforcement

Interact with social science instructors, student group advisors and other teachers to identify how the TAM's content can be reinforced and/or applied elsewhere.

6. Attitudes

Stress that often it is "soft" skills, such as communications, that make the difference between success and failure in real-life situations.

7. Remediation/Enrichment

A. Remediation: Place slower, more reluctant students in homogeneous groups where they can perform more easily for the first two exercises. Work hard to praise them and bolster their confidence.

B. Enrichment: Have faster students interview and video-tape successful industrialists in the community to identify how they have been impacted by leadership characteristics.

8. Summary & Review

- Nature of leadership
- Key component skills of leadership
- Communication essentials
- Planning processes

9. Review Questions & Answers (Answers are in italics)

A. What is the effect of differing leadership styles?
- *various employees and colleagues act differently*

B. The key steps to PERT planning are?
- *identifying activities*
- *identifying time estimates*
- *identifying relationships*
- *charting*

C. Three barriers/hindrances to effective communication are:
- *confusion of meaning*
- *emotion*
- *noise*

D. Effective delegation depends upon:
- *clarity*
- *acceptance*
- *follow-up*
- *reward*

Date: ________ Class: ______________________ Name: ________________

TAM #15 - Pre-test (Leadership)

Instructions: Circle the letter that correctly completes the sentence.

1. A leader is defined as:
   a. an individual who influences others to act toward a particular goal or end-state.
   b. an individual who directs the activities of a group toward a shared goal.
   c. an individual who initiates and maintains structure in expectation and interaction.
   d. all of the above.

2. We tend to evaluate leadership by considering whether an individual possesses certain:
   a. personality traits.
   b. social traits.
   c. physical characteristics.
   d. all of the above.

3. Managers are involved in:
   a. planning
   b. organizing
   c. directing
   d. controlling
   e. all of the above

4. Mangers should possess, in addition to their business and technical skills, universal skill(s) such as:
   a. human relations
   b. communication
   c. conceptualization
   d. decision-making
   e. all of the above

Date: ________ Class: ______________________ Name: __________________

TAM #15 - Post-test (Leadership)

Instructions: Fill in the blank spaces provided.

1. Management is the process of:
   a.________________, b.______________, c.________________ and
   d.________________ activities of employees.

2. There are three basic skills a manager should possess. These are:
   a.______________
   b.______________
   c.______________

3. Managerial jobs primarily involve (a)______________ while workers' jobs involve
   (b)____.

4. Various leadership theories emphasize the importance of a leader's
   (a)________________ to effectively (b)__________.

TAM #15 - Test Keys

TAM #15 - Pre-test Answers

1. d 2. d 3. e 4. e

TAM #15 - Post-test Answers

1. a. *planning*
   b. *organizing*
   c. *directing*
   d. *controlling*

2. a. *technical skills*
   b. *conceptual skills*
   c. *human relations skills*

3. a. *managing the work of others*
   b. *doing the job/carrying out the instructions of management*

4. a. *charisma*
   b. *lead*

TAM #15: Leadership Development

Student Component

Introduction:

Leadership is a most important characteristic. It leads to success in what one does. The skills you practice in this TAM will be useful throughout your life. Many of the principles and processes that you will use in this activity are used daily in industry.

Competencies: Following the completion of this TAM, you will be able to:

1. Identify characteristics necessary for leadership in technology. [8,I]
2. Identify the leadership quality characteristics of both present and past leaders in technology. [8,I]
3. Describe and illustrate qualities contributing to effective leadership. [8,II]
4. Demonstrate leadership in individual activity related to the course. [8,II]
5. Employ leadership skills in performing officer duties and guiding student organization activity. [8,III]
6. Work cooperatively with others in leader and follower roles. [8,III]
7. Bring group activity to a successful conclusion. [8,IV]
8. Participate effectively in local, state and/or national clubs. [8,IV]

Module Overview:

This activity is designed to have you practice some of the skills essential to effective leadership. Although they are presented separately, obviously in the real world all of these component skills blend into one. Therefore, it is recommended that you practice/apply these skills in an integrated manner.

This module contains four related activities:

1. Activity one is designed to develop effective communications.
2. Activity two is designed to develop effective delegation skills.
3. Activity three is designed to teach PERT planning.
4. Activity four is designed to establish your management style.

Key Information:

1. **Class Presentations**

   - Communication processes
   - Getting others to do tasks
   - Project analysis and planning
   - Individual and personal leadership

2. **Demonstrations**

   - Non-verbal communication
   - Assigning tasks
   - Project analysis and planning

3. **Safety**

   The typical safety concerns for physical injury do not apply to this TAM's activity but instead, you need to recognize the general responsibility one person has for another. Avoid doing anything at any time that has the potential of hurting/jeopardizing another.

4. **Personal Activity**

   This TAM is self-contained and all needed materials are included within it. As homework, you should read over the sections assigned by your instructor. If additional background or alternative exercises are desired, consult:

   Pfeiffer, J. (ed.). (1988). The annual: Developing human resources. San Diego, CA: University Associates.

5. **Other**

Activity Sequence:

1. Participate in your instructor's start-up activities and presentation for this TAM. Follow all instructions, e.g., reading the assigned material and reviewing the steps of procedure.
2. Complete the pre-test given by your instructor.
3. Do Activity #1 - Develop Effective Communications.
4. Do Activity #2 - Develop Effective Delegation Skills.
5. Do Activity #3 - Planning with PERT.
6. Do Activity #4 - Leadership Style.
7. Review and summarize.
8. Complete post-assessment procedure.

Glossary:

Communication	A process of getting an idea or some information from one person or machine to another (or group) in such a manner that information is shared.
Delegation	The assignment of responsibility to someone else.
Leadership	An ability to get others to follow your suggestions.
Nonverbal	Communication by a mechanism other than oral or verbal signals.
PERT	Program Evaluation Review Technique. This involves the systematic planning of an activity by identifying its components and their proper order and then flow charting it.
Planning	The process of preparing to effectively use management, communication and other skills for the accomplishment of an objective.
Role	The set of expectations and responsibilities that are associated with a real or imaginary job.
Role playing	The "acting out"/simulation of an assigned task.

Needed Materials:

1. Supplies

- Note paper
- Felt pens

2. Equipment

- Chart pad and easel

3. Handouts

A. Student component of TAM #15

4. Instructional Resources

A. Film (any business leadership oriented film. Check Section III, Part 4 for sources)

B. Books and Articles

Pfeiffer, J. (ed.). (1988). The annual: Developing human resources. San Diego, CA: University Associates.

C. A guest lecturer. For example, pick a local leader from any aspect of the community -- the characteristics are the same.

Activity #1 - Developing Effective Communications: Plan of Procedure

Together with your instructor work through the following steps:

1. The instructor announces the goals of the activity and directs you to the Shades of Difference Presentation. Take a few minutes to read the presentation. (Optional: the instructor may deliver the presentation orally). (Five minutes.)

2. The instructor divides the participants into groups of four by any appropriate method and directs the members of each group to designate themselves as member A, member B, member C and member D.

3. The instructor calls all members A together and points out to them the Shades of Difference Instruction Sheet A-C and the Shades of Difference Opinion Sheet 1. The instructor instructs the members A to read their sheets and prepare for their presentations. While members A are reading, the instructor tells the remaining members of the groups that they will be hearing a presentation of an opinion and that they are to listen carefully and to watch for the speaker's verbal and nonverbal indications that back up, or conflict with, his or her statement of opinion. (Five minutes.)

4. The members A return to their groups and present/read their opinion sheets aloud, as instructed. (Five minutes.)

5. Members B, C and D in each group give member A feedback on what nonverbal cues seemed to reinforce or detract from member A's presentation of the opinion. (Five to ten minutes.)

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6. The instructor calls the members B together and directs them to Instruction sheet B-D and to Opinion sheet 1. He/she tells them to read their sheets and prepare for their presentations. The instructor tells the remaining members that during each succeeding presentation, they are again to listen and watch for nonverbal cues. (Five minutes.)
7. The members B return to their groups and present/read their opinion sheets aloud, as instructed. (Five minutes.)
8. Members A, C and D in each group give member B feedback on what nonverbal cues he or she used that reinforced or detracted from his or her presentation. (Five to ten minutes.)
9. The instructor calls all members C together and points out the Instruction sheet A-C and the Opinion sheet 2, and directs them to read their sheets. (Five minutes.)
10. The members C return to their groups, present their opinions, and receive feedback from the other members of their groups. (Ten to fifteen minutes.)
11. The preparation, presentation and feedback process is repeated with the members D, who receive the Instructions for B-D and the Opinion sheet 2. (Fifteen to twenty-five minutes.)
12. You and your group member should now discuss how you felt while presenting your "opinions" and whether you were unusually aware of using nonverbal aspects of communication in your presentations. (Ten minutes.)
13. The instructor asks each group to select a recorder, gives blank paper and a pencil to each recorder, and asks the groups to identify the nonverbal cues that aided the presenters who were "for" the statements and those that aided the presenters who were "against" the statements while the recorder lists them. (Ten minutes.)
14. The total group is assembled, and the recorder from each group, in turn, reports the group's list of nonverbal cues that reinforced the "for" presentations. The instructor writes these on newsprint. Then each recorder reports his or her group's list of nonverbal cues that reinforced the "against" presentations, while the instructor records them on a separate sheet of newsprint. (Fifteen minutes.)
15. The instructor will ask you to suggest other nonverbal cues that you have used or seen someone use that could reinforce or negate what the speaker was saying or that carry a specific message of their own. These also are listed on newsprint. (Ten minutes.)
16. The groups of four are reformed, and the members are directed to discuss the answers to the following questions among themselves. (These questions are listed on newsprint and posted where all participants can see them):
    - A. What questions do you have about some nonverbal behaviors of your own that you think might confuse other people?
    - B. How might you improve your use of nonverbal communication to clarify or enhance your own communications with others?
    - C. What specific plans can you make right now to improve your use of nonverbal communication in your interaction with one other (specific) person?

(Fifteen minutes.)

TAM #15: Activity #1: Support Material

SHADES OF DIFFERENCE INSTRUCTION SHEET A-C

In a few minutes, you will be asked to read a statement of opinion to the other members of your group. Read the opinion as though you wholeheartedly agree with it and endorse it. Look now at the opinion that you have been given and think about how you might read it to the members of your group in a way that convinces them that you believe it and would like to convince them to believe it.

SHADES OF DIFFERENCE INSTRUCTION SHEET B-D

In a few minutes, you will be asked to read a statement of opinion to the other members of your group. Read this statement as though you are seriously opposed to the subject matter discussed. You may want to try reading the statement with sarcasm, pointing out its obviously ludicrous points with your voice. You may want to emphasize certain sentences that speak negatively against the subject themselves. Look now at the opinion that you have been given and think about how you might read it to the members of your group in a way that convinces them that you are opposed to the subject under discussion and that you would like them to oppose it also.

SHADES OF DIFFERENCE OPINION SHEET 1

Billboards are an important aspect of American business. Let's face it; in today's competitive environment, businesses need all the advertising they can get. What better way to send a message to Mr. and Mrs. America than to catch them while they are driving down the road without other things to distract them. The kids aren't in the bathtub; there's no one at the front door; there's nothing in the oven--just the scenery and the billboards. In fact, billboards are the scenery in some places. They brighten up lonely stretches of road; they provide art in a barren landscape. More importantly, they tell people about products and services that they might not hear about in other media such as television, newspapers, magazines and radio. Billboards help the consumer to choose between products and services (why this cigarette is better than that cigarette; why this bank is more trustworthy than that bank, etc.). People have come to expect to see billboards; they've become part of the American way of life.

TAM #15: Activity #1: Support Material

SHADES OF DIFFERENCE OPINION SHEET 2

Soap operas and their prime-time counterparts have become part of American life. People watch them to find out how other people live, to gain insight into the personalities of people who make things happen, and to bring a glimpse of the real world into their ordinary lives. In soap operas, the men usually are doctors or lawyers or have inherited money, and the women don't work and don't need to. This vision of how the other half lives is made more realistic by the situations and crises that the characters face. People watch the problems and conflicts of the characters in a soap opera or family saga and compare them to help them put their own lives and problems into perspective. The "soaps" tell people that there are many different kinds of families with many different kinds of problems but also that, in many ways, we are all alike. These dramatic portrayals help people to distinguish between right and wrong, between what is really important and what is not. They help us to consider the moral implications of things that could happen to you or me.

SHADES OF DIFFERENCE PRESENTATION

People communicate in more than one way. What we say to another person is only one of the messages that we send. My tone of voice, pitch, and use of pauses can tell you that I am joking, that I am very serious, that I am angry or sad, and so on. My gestures, my bodily stance, the tilt of my head, and the way I use my eyes or eyebrows also can convey a message or reinforce or negate the verbal message that I am sending. Even the words or sounds that I use between pauses can indicate whether I am feeling sure or unsure, honest or dishonest, or a number of other conditions. These various messages are known as nonverbal ("along with" or "beyond" verbal) communication. Your interpretation of my communication is based on several things: your needs and feelings, the words I use, the way I use my voice in saying those words, the way I stand or sit, the way I look at you, my gestures, and so on. If my "body language" and my voice are not congruent with my words, you may become confused or you may distrust my intentions. In fact, if my nonverbal communication is incongruous with my stated message, it may indicate that I am feeling ambiguous or unclear about what I am trying to communicate. (In some cases, I may be trying to confuse you.)

If I want my communication with you to be as clear and unambiguous as possible, I need to pay attention to all the messages that I send at one time. If I am joking, I can smile or raise my eyebrows to let you know that I am joking. If I am trying to extend sympathy but fear that my awkward words will sound gruff, I can speak softly and perhaps touch your shoulder.

By paying attention to how we communicate--on many levels--we can do a great deal to improve the clarity and effectiveness of what we are attempting to communicate.

TAM #15: Leadership Development

Activity #2 - Delegating Effectively: Plan of Procedure

Together with your instructor work through the following steps:

1. The instructor introduces the goals of the activity.
2. Begin by brainstorming definitions of delegation. As definitions are mentioned, the instructor writes them on newsprint. After you have exhausted you ideas, the instructor summarizes the definitions listed on newsprint and points out common elements in these definitions. The newsprint list remains on display so that you can refer to it later. (Ten minutes.)
3. The instructor assigns you to subgroups of five or six members each; asks each subgroup to be seated at one of the tables, and explains that each subgroup's task is to discuss the reasons that people do not delegate and the benefits for those who do. The subgroups are instructed to appoint recorders to list these barriers to delegation and benefits of delegation. Each subgroup is given blank paper and a pencil for the recorder's use during this task. The instructor further explains that in fifteen minutes each recorder will be asked to report the results of the discussion. Then the participants are instructed to begin. (Twenty minutes.)
4. The instructor reassembles the total group and asks the recorders to take turns reporting the results of the subgroup discussions. As the barriers and benefits are announced, the instructor records them in two separate lists on newsprint and posts the list next to the one generated during Step 2. (Fifteen minutes.)
5. Note your copy of the Delegation Theory Sheet, and read it now. (Five minutes.)
6. The instructor leads a brief discussion of the content of the theory sheet, clarifying as necessary and pointing out similarities and differences between that content and the information listed on the posted newsprint. (Ten minutes.)

7 Note your copy of the Delegation Check List and read it now. (Five minutes.)

8. The instructor elicits and answers questions about the content of the check list. (Five minutes.)
9. Note your copy of the Delegation Record Sheet and think about your responsibilities. List in the far-left column on the record sheet several tasks or projects that could be delegated but currently are not. You need not complete the other columns at this time. (Five minutes.)

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TASKS
Mary
Joe

10. The subgroups are reassembled at their tables your instructor asks each subgroup to select one task or project from those listed by the subgroup members. Each subgroup is to plan the delegation of this task or project by asking questions based on the check list. To determine the appropriate subordinate for the task, each subgroup member is to consider which of his or her own subordinates would be best for the task and to present this subordinate's qualifications to the subgroup; then the subgroup members are to arrive at a consensus about who is best suited for the task. The instructor instructs each subgroup to select a recorder to fill out the first four columns of a record sheet (all columns except "Progress Notes") in accordance with the subgroup's plan. Then the subgroups are instructed to begin. (Thirty minutes.)

11. The total group is reassembled, and the instructor asks the following questions:

    A. What kind of task did you choose to delegate?

    B. What type of subordinate did you choose to do the work?

    C. What feelings did you experience in thinking about delegating the task to the particular person chosen?

    D. What discoveries did you make about the delegation process?

    E. How do your discoveries fit with what happens in your organization? How do they fit with the information about delegation in the theory sheet?

    F. How can you ensure that you will follow through on delegating the tasks you listed on your own personal copy of the record sheet? (Twenty minutes.)

12. The instructor suggests that each participant keep the handouts to refer to or use on the job. After making final comments, the instructor concludes the activity.

DELEGATION THEORY SHEET

Delegation is accomplishing organizational purposes through the proper deployment of people. Defined in this way, delegation is nearly synonymous with leadership. In fact, delegation involves skills that are requisite qualities of leaders. Setting goals, coaching, and recognizing performance are all elements of the delegation process and are essential attributes of leaders. Similarly, the aims of the delegation process and leadership are similar: to accomplish organizational ends while enhancing the abilities, confidence and initiative of one's staff.

The benefits of delegation outweigh the potential drawbacks, yet many managers are hesitant to delegate in spite of the fact that most tasks can be delegated. Only responsibilities that demand personal attention, such as handling a performance problem, or duties inherent in the manager's job, such as setting his or her unit's goals, should not be delegated.

There are a myriad of reasons that managers use to justify not delegating. Few are legitimate reasons, and the usual consequence is impaired managerial functioning. Common reasons for not delegating include the following:

- Insufficient time;
- The perception that the job is too important to take risks;
- The manager's belief that he or she can do the job best;
- The fact that the manager enjoys doing certain jobs;
- A lack of confidence in subordinates;
- The desire to maintain control;
- Fear that a subordinate might do the job better than the manager; and
- Concern that the manager's boss will think that the manager is not working.

There is one additional reason that managers do not delegate: they may not know how. The process requires planning and patience; and, in general, it works best when the manager employs a participatory-management style. Consider the following two approaches to delegating the same task:

1. The manager communicates to the subordinate a need to inform the company's field sales staff about a new product by saying, "Copy this product fact sheet onto company letterhead and mail it to our two thousand sales personnel by next Friday."

2. The manager informs the subordinate what needs to be accomplished (notifying field sales personnel of a new product) and asks the subordinate to think about how this task could best be achieved. After the subordinate devises a plan, the manager and subordinate discuss it.

In the first example, the "delegation" offers the subordinate no room for growth or self-direction; the instructions are offensive in that they treat the subordinate as someone incapable of independent thought. In the second example, the subordinate's plan might offer no more than the obvious: copying the product fact sheet and doing a mass mailing. However, the climate engendered by the second example is qualitatively different from the one created in the first example; it includes the element of respect. The subordinate is trusted to develop a plan of his or her own.

The irony of a delegation process like the one in the second example is that the manager as well as the subordinate frequently learns from it. For example, the employee might know that the corporate magazine will be issued in time to include an announcement of the new product. This might be an alternative method of approaching the task that the manager had never considered.

The delegation process is conceived as having five specific phases:

1. *Preparation*: establishing the goals of the delegation, specifying the task that needs to be accomplished, and deciding who should accomplish it;
2. *Planning*: meeting with the chosen subordinate to describe the task and to ask the subordinate to devise a plan of action;
3. *Discussion*: reviewing the objectives of the task as well as the subordinate's plan of action, any potential obstacles, and ways to avoid or deal with these obstacles;
4. *Audit*: monitoring the progress of the delegation and making adjustments in response to unforeseen problems; and
5. *Appreciation*: accepting the completed task and acknowledging the subordinates efforts.

When delegating, there are several important points to keep in mind:

1. Unless the manager can visualize and articulate what he or she wants in terms of results, the process will fail.
2. The manager must stretch the capabilities of his or her staff; repeatedly assigning the same jobs to the same people because they do them well does not foster development within the manager's unit.
3. The manager must let the chosen subordinate know how the assigned task fits into the unit's major objectives and to what extent the subordinate is empowered to act in the unit's behalf. Without this information, it is difficult for the subordinate to operate independently.
4. The delegation should never be revoked. Doing so, undermines what a manager wished to establish: initiative.
5. The manager should never accept unfinished or unsatisfactory work. Such acceptance communicates tolerance of low standards.
6. Completed work should be evaluated against the results that the manager wanted to achieve, not against the way in which the manager would have achieved them.
7. A satisfactory outcome should be recognized. Many delegations fail because hard work goes unappreciated and forgotten. At the very least, the appreciation of a successfully completed task should be rewarded with the chance to be given another challenging task at a future date.

Delegation Check List

Preparation Phase

Specify for yourself the goals of the delegation, what needs to be done and by whom.

1. Specify the job to be delegated:
    - Results expected;
    - Materials, resources and information needed;
    - Relevant policies and procedures to be considered;
    - Time frame for project; and
    - Others involved in project (suppliers, others doing parts of the work, and so forth).
2. Decide to whom the task will be delegated:
    - Consider subordinates' abilities, knowledge, interests, experience, attitudes, confidence, developmental goals and so forth;
    - Consider subordinates' current work loads; and
    - Consider the types of tasks and/or projects that subordinates are currently working on.

Planning Phase

The subordinate who is chosen is briefed on the project to be completed and is asked to formulate a plan of action. A more lengthy follow-up meeting is scheduled.

1. Explain the reasons for delegating to this person.
2. Describe the project clearly (results expected and so forth), including how the project fits into the larger scheme of things. Ask the subordinate to prepare a plan of how the job could be accomplished and to specify what obstacles he or she anticipates as well as ways to avoid or deal with these obstacles.
3. Establish a meeting time to discuss the subordinate's ideas and determine how long to meet.
4. Arrange for the meeting to take place in a nonthreatening location.

Discussion Phase

Review the project objectives with the subordinate and discuss ideas on how he or she plans to proceed, what obstacles he or she anticipates and how these obstacles can be avoided or dealt with.

1. Discuss the subordinate's plan of action and ways of overcoming potential obstacles.
2. Specify the resources that will be made available and make any necessary introductions to others who will be involved in the project.
3. Tell the subordinate how much authority you will confer.
4. Discuss how much follow-up to expect; establish checkpoints.
5. Emphasize the subordinate's responsibility for the outcomes.

Audit Phase

Monitor the progress of the delegation; make adjustments in response to unforeseen problems.

1. Make sure that needed materials, resources and so forth are available to the subordinate.
2. Discuss problems and progress at designated check points and/or as needed.
3. Offer encouragement; do not revoke the delegation or begin to perform elements of the task yourself.

Appreciation Phase

Accept the completed project and acknowledge the subordinate's efforts.

1. Do not accept unfinished, inaccurate, unprofessional or off-target work.
2. Show an interest in the results; reward the subordinate for achievements.
3. Accept your own accountability. Do not blame the subordinate for less-than-satisfying results for which you may be responsible.
4. Review the delegation process and what has been learned.

Delegation Record Sheet

Task	Expected Results	Delegated Person	Checkpoints	Progress Notes

TAM #15: Leadership Development

Activity #3 - Planning with PERT: Plan of Procedure

1. The instructor delivers a presentation on PERT and CPM. The presentation will show how both simultaneous and sequential activities are dealt with by PERT and how the critical path is constructed. The instructor draws a PERT chart on newsprint as part of the presentation. (Fifteen to thirty minutes.)
2. The instructor will assign you to groups of five members each if possible (four or six members each if necessary), and direct the groups to assemble in different areas of the room. (Three minutes.)
3. Note the Quick Change Instruction Sheet and read it at this time. If you have any questions, get the instructor to clarify matters. (Fifteen minutes.)
4. The instructor distributes newsprint and felt-tipped markers to the groups, reminds them that they are to draw their PERT charts on the newsprint and tells them that they have twenty minutes in which to complete the task.
5. The instructor gives a time warning after fifteen minutes and calls time after twenty minutes. Each group's chart is posted, and one member of each group in turn, explains the group's chart. (Thirty to forty minutes.)
6. The instructor points out the Quick Change Answer Sheets and describes the procedure, timing and critical path step-by-step. (Ten minutes.)
7. The participants are directed to take ten minutes to discuss within their groups:
   - A. Their reaction to the experience.
   - B. Problems they encountered in developing their charts.
   - C. Questions about PERT or CPM that need clarification.
8. The entire group is assembled, and a spokesperson from each group reports on the group's discussion. The instructor lists the key points and any questions on newsprint. (Fifteen Minutes.)
9. The instructor solicits answers and comments from all participants regarding the questions and points listed. (Five minutes.)
10. The entire group discusses the uses of the PERT and CPM processes and suggests situations in which these processes would be helpful. (Ten minutes.)

Reproduced from The 1988 Annual: Developing Human Resources. J. William Pfeiffer, Editor, San Diego, CA: University Associates, 1989; and previous years.

TAM #15: Activity #3

Quick change instruction sheet

Background: you are members of a famous race car pit crew. The secret of your success is that your pit stops always are well planned. For your next championship, you have to win the season's final race. From your analysis, you have discovered that winning this race will come down to the last pit stop for only one tire because you will have just enough gasoline to avoid the lengthy refueling time. You now want to determine if the pit stop can be successfully completed in the 21 seconds needed to win the race.

To complete the pit stop, several things have to happen in very close coordination. The driver has to enter pit road and stop the car. The pit crew (Jacker, Pit boss, Tire changer) have to get into their proper positions. The Jacker has to raise the car, the Tire changer has to undo the wheel and switch/tighten the new one. The Pit boss of course has to position the new wheel next to the Tire changer. Meanwhile, the driver is getting a drink as he guns the engine to keep it from stalling. The Jacker cleans the window also. The Jacker lowers the car and the Tire changer removes tools from in front of the car. Once everything is ready, the Pit boss signals the driver who races out of the pit to rejoin the race. Simple isn't it. To be sure, but not when all this has to be done in 21 seconds or less.

Your task: To create a PERT chart for the pit stop. In doing so, you must answer these questions:

1. Can the pit stop be accomplished in the 21 seconds or less in order to win the race?

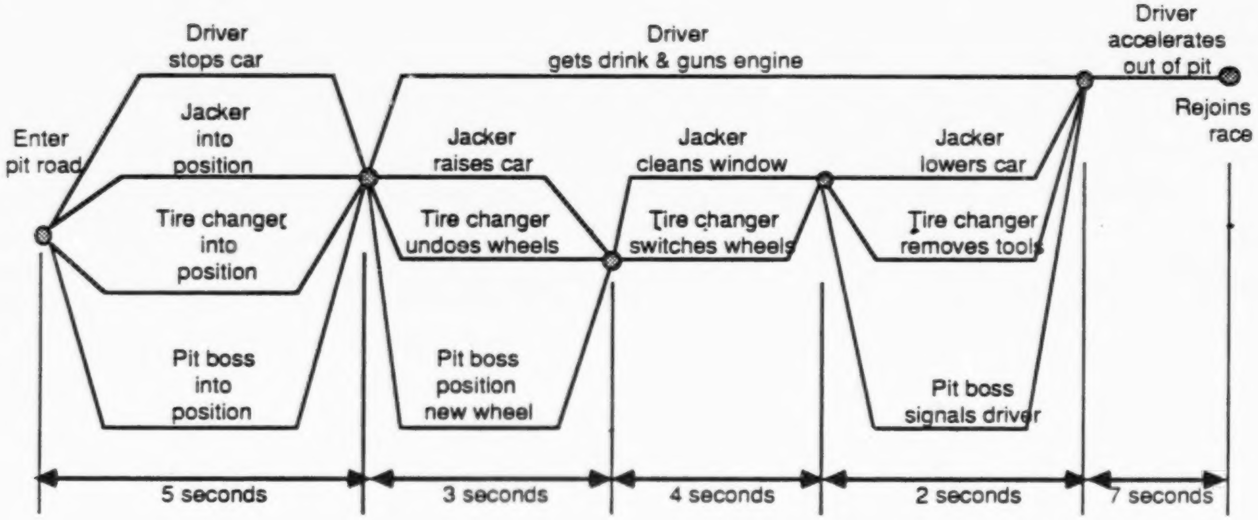
2. How quickly can it be accomplished? (What is the Critical path?)

Participants to be scheduled:

- 1 Driver
- 1 Pit boss
- 1 Jacker
- 1 Tire changer

Activities	*Time required*	*Person*
1. Enter pit road and bring car to a stop	5 seconds	Driver
2. Get into position	2 seconds	All other than driver
3. Take a drink	5 seconds	Driver
4. Gun engine to keep from stalling	9 seconds	Driver
5. Jack up the car	3 seconds	Jacker
6. Undo wheel	3 seconds	Tire changer
7. Position replacement wheel	2 seconds	Anyone available
8. Clean window	3 seconds	Anyone available
9. Mount new wheel	4 seconds	Tire changer
10. Lower car	1 second	Jacker
11. Remove tools	2 seconds	Anyone available
12. Signal driver	1 second	Pit boss
13. Leave pit and rejoin race	7 seconds	Driver

Quick Change Answer Sheet (one solution)


Enter
pit road
Driver
stops car
Jacker
into
position
Tire changer
into
position
Pit boss
into
position
Driver
gets drink & guns engine
Jacker
raises car
Tire changer
undoes wheels
Pit boss
position
new wheel
Jacker
cleans window
Tire changer
switches wheels
Jacker
lowers car
Tire changer
removes tools
Pit boss
signals driver
Driver
accelerates
out of pit
Rejoins
race
5 seconds
3 seconds
4 seconds
2 seconds
7 seconds

TAM #15: Leadership Development

Activity #4 - Leadership Styles: Plan of Procedure

Together with your instructor, work through the following steps:

1. The instructor announces that you are going to do some role playing activity and then you to groups of four members each.
2. Note your copy of the Management Perspectives Situation Sheet and read it at this time. (Five minutes)
3. Note the various role sheets and the name tags given to each group member. Be sure that each of the four members in each group is assigned a different role. Now read the handouts that correspond to your name tags. Wear your name tags throughout the entire activity. In addition, do not to reveal the contents of your role sheets to your fellow group members. (Ten minutes)
4. Take paper, a pencil, and a clipboard and spend fifteen minutes devising and recording a solution to be presented at the upcoming managers' meeting. The instructor emphasizes the importance of maintaining assigned roles during this step and the meeting that follows.
5. At the end of the fifteen-minute period, your groups will begin their meetings.
6. After thirty minutes, the instructor stops the group meetings, points out the Management Perspectives Theory Sheet, and asks you to read it. (Ten minutes)
7. Note the Management Perspectives Discussion Sheet. Each group is to discuss answers to the questions on the sheet. Each group should select a reporter to record answers, summarize them and report the summarized answers later to the whole class. (Thirty minutes)
8. The class is reconvened, and the reporters are asked to share the summarized results of the group discussions. (Twenty minutes)
9. The instructor leads a concluding discussion concerning the ways in which you might apply what they have learned in your own environments.

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TAM #15: Activity #4: Support Material

Management Perspectives Situation Sheet

You are a plant manager of a factory. A year ago another manager's plant was selected to be redesigned as " the factory of the future." New state-of-the-art word-processing equipment, automatic machines and computer terminals were installed. These changes meant that one employee working with a single piece of equipment could provide immediate responses to inquiries that were previously processed through the joint efforts of several employees over a period of days.

At the same time, two new staff members joined the plant. One was hired as an office supervisor because of her understanding of the word-processing and microcomputer equipment, and the other was named as supervisor of production because of his understanding of the main computer. The rest of the staff was trained in the use of the new equipment. This training seemed to progress as planned, and the employees developed a level of understanding and competence that was determined to be acceptable.

Top management announced these changes throughout the organization and had high hopes that the plant would evolve into a model of increased productivity and efficient operation. However, this has not been the case.

Before the changes took place, the plant employees and their manger functioned productively as a close-knit, content group. But soon after the changes were instituted, it became known that the employees were beginning to complain. They were disappointed with the new equipment, which malfunctioned frequently, and in their new work environment, which they described as cold and impersonal. Another situation that distressed them involved the removal of the time clock. When the clock was first removed and the employees were no longer required to "punch in" and "punch out," they saw this development as a sign that the organization had more trust in them; but subsequently they discovered that the newly installed computer equipment was verifying their comings and goings. Discontent over these and other concerns grew and, despite a healthy economy, the plant began to experience a drop in performance. Things progressively worsened until finally, a week ago, the plant manager became so frustrated that she quit.

Now the plant is without leadership, and top management has asked you and three other plant mangers to meet to determine the source of the problems within the redesigned plant and to arrive at a solution to these problems. Each manager has been instructed to work independently to develop a solution and to bring this proposal to the meeting, which is to take place shortly.

TAM #15: Activity #4: Support Material

Management Perspectives Role Sheet A

Manager A

You feel that the present problems in the redesigned plant are obviously attributable to the people who work there. If the plant employees have not yet adapted to the new equipment and procedures, they probably are incapable of functioning in "the factory of the future." It is also possible that the two new supervisors are not the equipment experts that they were assumed to be and are, therefore, to blame for inadequately training the employees.

If you had had your way from the beginning, you would have chosen only one type of employee for the redesigned plant: the type who strictly follows, and does not deviate from, instruction. In the actual process used to institute the changes at the plant, too much emphasis was placed on helping existing employees to understand the new procedures. Actually, all they needed to know was what buttons should be pushed and at what time.

One issue about which you are particularly sensitive is the new equipment at the redesigned plant. You believed this equipment to be the best available. In fact, you were a member of the task force that investigated different kinds of equipment and ultimately suggested that the present models be purchased. Although you know it is true that the equipment malfunctions occasionally, you attribute such breakdowns to the incompetence of the people who use it. You even have support for your position in this matter: a recent report on the "down time" of the equipment was submitted by the supplier, and it implies that the plant employees are to blame rather than the machinery itself. Therefore, during the upcoming meeting, you plan to make it clear that the new equipment cannot possibly be the source of the present problems.

You are certain that the solution you come up with will be the best alternative, and you plan to support it at all costs.

Management Perspectives Role Sheet B

Manager B

You are convinced that the source of the problems at the redesigned plant is the lack of emphasis on human relations. Throughout the year since the changes were instituted, the plant employees have been complaining. As you suspected from the outset, the employees were not consulted about the type of equipment or procedures that should be used, just as they were excluded from the decision-making process that led to the creation of the "the factory of the future."

Furthermore, the employees state that the new equipment continually breaks down and makes it impossible for them to work efficiently. Although you recently read a report implying that the malfunctions were caused by human error, you dismissed the contents; because the report was submitted by the supplier of the equipment, its conclusions can scarcely be regarded as legitimate.

It seems to you that top management, in redesigning the plant, was operating under the philosophy that the equipment should control the flow of work, a viewpoint that you consider unacceptable. Instead, the primary emphasis should be on the employee, without whom the equipment is useless. As you have always said, when the organization fulfills its responsibility to meet the employees' needs, everything else falls into place and organizational goals are met automatically. After all, the plant employees were happy before the redesigning process, and productivity then was considerably higher than it is now. Under the new system, they have to cope not only with a reduction in the amount of teamwork that previously had promoted morale and satisfaction, but also with new supervisors who were hired because of their computer skills instead of their management skills. During the upcoming meeting, you plan to point out top management's error in judgement.

You are certain that the solution you come up with will be the best alternative, and you plan to support it at all costs.

Activity #4: Support Material

Management Perspectives Role Sheet C

Manager C

In your opinion the problems in the redesigned plant are attributable to one source: a failure to provide the employees with opportunities to fulfill their individual needs and their natural desire to do competent work. You formed this opinion on the basis of what you have learned about employees in general as well as those at the troubled plant. The plant employees, like your own subordinates, are mature adults who want to do their best for the factory; they enjoy their work and supervise themselves well in completing it. Indeed, their performance record and their level of job contentment before the redesigning prove that this is the case.

In its plans to redesign the plant, the factory's top management has overlooked these facts and has chosen to treat the employees like lazy children. New supervisors were brought in to monitor their work, and new equipment was programmed to keep track of their comings and goings. The employees were expected to meet new organizational goals for increased productivity while their needs for autonomy, self-direction and a sense of fulfillment were ignored. Under the circumstances, a drop in productivity is inevitable. You feel strongly that the present organizational attitude toward employees is counter productive, and you plan to make your feelings known during the upcoming meeting.

You are certain that the solution you come up with will be the best alternative, and you plan to support it at all costs.

Management Perspectives Role Sheet D

Manager D

As far as you are concerned, the source of the problems at the redesigned plant is a failure to analyze and respond to all of the factors involved before the changes were implemented. The situation at the plant was and is complex. Top management had no choice but to respond to technical advances that would allow the factory to remain competitive, but too much was attempted too fast and without adequate preparation. In addition, the needs of the plant employees should have been met to a greater degree, and the social climate within the plant should have been considered.

However, you feel that it is time to face the situation and rectify it. It is highly impractical to consider such solutions as firing all of the plant employees, abandoning concerns about productivity and competitiveness, or attempting to effect overnight changes in the way in which the organization and top management operate. The solution must incorporate social and technological goals within the context of internal and external environmental pressures. Your objective during the meeting is to convince your fellow members to see the whole picture as it really is rather than as their special interest may compel them to see it.

You are certain that the solution you come up with will be the best alternative, and you plan to support it at all costs.

Management Perspectives Theory Sheet

Over the years, a number of approaches to management have been developed and promulgated in an attempt to provide effective leadership within organizations. The role-play situation in which you have just been involved has characterized four of these approaches, which are described below.

The Scientific Approach (Manager A)

Frederick Taylor is known as the father of the scientific approach to management. In the early 1900's he analyzed the loading of pig iron onto railroad cars at Bethlehem Steel and determined that he could devise techniques for increasing the workers' productivity.

After observing the workers carefully, Taylor selected a few whom he felt could tolerate the new pace he would set, and from this group he ultimately chose one individual for his project. This worker was instructed to do exactly as he was told and only as he was told. By closely adhering to Taylor's methods, the worker was able to increase his average loading per day from 12.5 to 47.5 tons.

Although this initial effort was deemed successful, Taylor's work, reputation, and the entire approach of scientific management eventually suffered because of his negative opinion of workers. He defined the worker in the Bethlehem Steel situation as "mentally sluggish," and he described the ideal pig-iron worker as close to an ox in his mental abilities. Subsequently, he was condemned by many, not because of his devotion to increasing productivity through applying the results of time-and-motion studies, but because of his lack of sensitivity to the human element.

Today, we tend to associate Taylor's approach with the attitude that success must be achieved at any cost. This high concern with mechanics of tack, when combined with a low concern for people, is now thought to be quite psychologically damaging to workers. Nevertheless, it characterized industrial work for a number of years and is still prevalent in many areas of our society.

The Human-Relations Approach (Manager B)

Elton Mayo, a social philosopher of the 1920s and 1930s, held views that were in direct opposition to those of Frederick Taylor. While Mayo was a faculty member at Harvard, he was responsible for experiments that took place at Western Electric's Hawthorne plant. These experiments formed the basis of the human-relations approach to management.

Mayo believed that productivity could be increased by involving workers in the decision-making process. After analyzing the results of the Hawthorne experiments, Mayo concluded that they supported his belief, although many have debated this conclusion in the years since.

Whereas the scientific approach came to be maligned because its originator held an unacceptable view of the worker, the human-relations approach ultimately came to be maligned because it excluded a concern for profit in favor of the contentment of workers. Although Mayo himself recognized the legitimacy of the profit motive and sought to incorporate this motive with that of worker involvement in decision-making, those who adopted his approach eventually became convinced that if a company's workers were happy, the company itself would automatically prosper. Managers who espoused this notion saw their responsibility as catering to the needs of their workers almost to the exclusion of their companies' needs. This approach developed a considerable following during the 1930s, 1940s, and early 1950s, but by the mid-1950s it became obvious that increased productivity could not be achieved solely by assuring the happiness of workers.

Behavioral-Science Approach (Manager C)

One of the important outcomes of the human-relations approach was that it prepared the way for the behavioral-science approach. Douglas McGregor, one of the earliest and most influential proponents of this approach to management, began to expound his ideas in the late 1950s. McGregor based his views of management on different managerial attitudes towards worker motivation. He designated as "Theory X" a managerial style based on the assumption that workers are basically lazy, do not wish to accept responsibilities, must be closely controlled and do not wish to be involved in the solution of organizational problems. The opposite style, which McGregor called "Theory Y," is governed by the assumption that workers actively seek and willingly accept responsibility, are naturally goal oriented and self-controlled at work, and are willing and able to help in solving organizational problems.

McGregor's answer to the excesses of the scientific and the human-relations approaches was Theory Y: Management must, of course, meet organizational goals, but it should also design work in such a way that it provides workers' with opportunities to meet their own needs as well. This approach takes full advantage of workers' natural motivation to the mutual benefit of the workers and their organization. Because worker needs fall generally into the categories of social, esteem and self-development, ample opportunities can be offered to fulfill them. For example, it is perfectly conceivable that a worker's job can be designed to afford him or her an opportunity to gain prestige, a sense of achievement or knowledge.

When managers tried to apply this theory, however, they encountered a problem. A certain kind of organizational structure and environment is required to support Theory Y behavior on the part of a manager. An organization that adheres predominantly to Theory X, for instance, is no place in which to try this approach.

Sociotechnical-Systems Approach (Manager D)

The sociotechnical-systems approach, set forth by Fred Emery, Eric Trist, and others during the 1950s, 1960s, and 1970s, combined elements from the three approaches previously discussed in an attempt to address the complexity of variables that exists within contemporary organizations. This approach recognizes the concerns of an organization that must adapt to technical advances. but still must attend to its internal social environment as well as the larger environment within which it functions. The responsibility of each organization, if it is to survive, is to analyze its own situation with regard to social, technical, and environmental factors and then to choose a structure and a method of operation that works within the context of these factors. Therefore, not all organizations can or should be alike.

This concept recognizes that just as no organization operates within a vacuum, so does no manager. In order to know how to behave, a manager must weigh human needs, technological concerns, and both internal and external environmental pressures. Although the sociotechnical-systems approach does offer managers and their organization a way to respond to changing conditions, it is not a panacea and does not pretend to be one. Even Trist has expressed a fear that the technological advances of the next few decades will outdistance the ability of the sociotechnical-systems approach to deal with them.

TAM #15: Activity #4: Support Material

Management Perspectives Discussion Sheet

1. What positive reactions did you have while playing your assigned role? What were your negative reactions?

2. Which concerns from other group members had the greatest impact on you? What meaning did you attribute to these comments?

3. What do you consider to be the advantages of the managerial approach that you represented during the role play?

4. What do you consider to be the disadvantages?

5. How closely does your assigned role-sheet style resemble your own managerial approach?

6. Which approach is most characteristic of your own organization? How does this approach affect your organization?

7. How acceptable would your assigned role-sheet style be in your own organizational environment? What elements of the style would be acceptable or unacceptable?

TAM #15 - Summary

1. **Review & Summary Activities**

   This TAM introduced you to four essential competencies in leadership. They were delegating, planning, communicating and leading. You will have many opportunities to apply these skills in school, personal and work activities. Practice them every time you use them and you will be amazed at the results and with yourself!

2. **Review Questions -- Test yourself!**

   A. What are the key steps in communicating?

   B. Why is leadership such a difficult thing to do well?

   C. What does the term "critical path" mean?

   D. When delegating one must be careful to:

TAM #15 - Post-assessment

Instructions:

1. Complete a self-check to insure that you have done what was asked in each activity.
2. Discuss your individual and group performance with your instructor.
3. Complete the post-test for TAM #15.
4. If your results demonstrate mastery, go on to the next TAM or activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Section III: Resources

Part 1: Books & Resources

________. (1972). The CBIE Project: A cooperative curriculum effort in the area of materials and processes. Topeka, KS: The Kansas State Department of Education.

________. (1973). Industrial arts and the challenge of an urban society. Washington, D.C.: National Education Association. American Industrial Arts Association.

________. (1974). Fiberglass/Plastics. Fundamental of Service Series. Moline, IL: John Deere Co. [ERIC ED 185 427]

________. (1977). Curriculum guide for industrial arts education: Energy and power. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

________. (1977). Industrial arts and space technology: Conference proceedings. Washington D.C.: National Education Association Association. American Industrial Arts Association.

________. (1977). Manufacturing: A curriculum manual. Santa Fe, NM: New Mexico State Department of Education,Vocational-Technical Division. (Activities)

________. (1979). A catalog of tasks for competency-based instruction in materials and processes technology. Richmond, VA: Department of Education.

________. (1980). Industrial arts curriculum guide: Woodworking. Hartford, CT: Connecticut State Department of Education, Division of Vocational Education, Bureau of Vocational Services.

________. (1980). Materials and processes technology. Richmond, VA: Virginia Department of Education. (Activities)

________. (1981). AIASA guide for industrial arts programs. Blacksburg, VA: Virginia Polytechnic Institute and State University.

________. (1981). Eye safety: Mississippi industrial arts. Mississippi State, MS: Mississippi Research and Curriculum Unit for Vocational and Technical Education, State College. [ERIC ED 215 186]

________. (1981). Industrial arts curriculum guide for plastics. Hartford, CT: Connecticut State Department of Education, Division of Vocational Education. [ERIC ED 204 626]

________. (1981). Industrial arts curriculum guide for safety. Hartford, CT: Connecticut State Department of Education, Division of Vocational Education. [ERIC ED 204 629]

________. (1981). Industrial arts curriculum guide in basic woodworking. Bulletin No. 1684. Baton Rouge, LA: Louisiana State Department of Education, Division of Vocational Education. [ERIC ED 223 836]

________. (1981). Industrial arts curriculum guide in general industrial arts. Bulletin No. 1683. Baton Rouge, LA: Louisiana State Department of Education, Division of Vocational Education. [ERIC ED 223 835]

________. (1981). Safety guide for vocational, technical, and industrial education. Santa Fe, NM: New Mexico State Department of Education.

________. (1981). Safety with hand and portable power tools. Module SH-14: Safety and Health. Waco, TX: Center for Occupational Research and Development. [ERIC ED 213 853]

________. (1982). General metal trades book I. Units of instruction: Teacher's guide. Austin, TX: Texas Education Agency, Department of Occupational Education and Technology. [ERIC ED 222 716]

________. (1982). Industrial arts curriculum guide for industrial ceramics. Hartford, CT: Connecticut State Department of Education, Division of Vocational and Adult Education. [ERIC ED 222 671]

________. (1982). Industrial arts curriculum guide for metalworking. Hartford, CT: Connecticut State Department of Education, Division of Vocational and Adult Education. [ERIC ED 222 672]

________. (1982). Industrial arts curriculum guide in basic metals. Bulletin No. 1685. Baton Rouge, LA: Louisiana State Department of Education, Division of Vocational Education. [ERIC ED 223 837]

________. (1982). Vocational education curriculum guide: General industrial arts. Baton Rouge, LA: Louisiana Department of Education.

________. (1982). Vocational education curriculum guide: Industrial ceramics. Baton Rouge, LA: Louisiana Department of Education.

________. (1983). AIASA member guide. Reston, VA: Technology Student Association.

________. (1983). Career achievement plan (Career Map): Manufacturing technology. Tallahassee, FL: Florida Department of Education.

________. (1983). Contemporary approaches for teaching technology. Reston, VA: American Council of Industrial Arts Supervisors.

________. (1983). Dictionary of occupational titles. Washington, DC: United States Department of Labor, Employment and Training Administration.

________. (1983). National technical information service - general catalog of information services. Springfield, VA: US Department of Commerce, NTIS #8A.

________. (1984). Computer programs in industrial arts/technology education. South Holland, IL: Goodheart-Willcox.

________. (1984). High school industrial arts: A guide for teachers. Salem, OR: Oregon Department of Education. [ERIC ED 255 646]

________. (1984). Industry & technology education: A guide for curriculum designers, implementors, and teachers. Bulletin No. 4432. Madison, WI: Wisconsin State Department of Public Instruction. [ERIC ED 248 340]

________. (1984). Production technology curriculum guide. No. 272c. Springfield, IL: Illinois State Board of Education. (Activities)

________. (1984). Robotics in industrial arts: Final narrative report for the exemplary project. Donaldsonville, LA: Ascension Parish School Board. [ERIC ED 262 182]

________. (1984). Technology learning activities. Albany, NY: New York State Education Department.

________. (1985). Advanced metals (Industrial arts) curriculum guide. Bulletin 1750. Baton Rouge, LA: Louisiana State Department of Education, Division of Vocational Education. [ERIC ED 261 259]

________. (1985). Advanced woodworking (Industrial Arts) curriculum guide. Bulletin 1752. Baton Rouge, LA: Louisiana State Department of Education, Division of Vocational Education. [ERIC ED 261 257]

________. (1985). Directory of curriculum guides and other key resources. Reston, VA: International Technology Education Association.

________. (1985). Industrial arts education teacher handbook: Vocational education, Grades 9-12. North Carolina Competency-Based Curriculum. Raleigh, NC: North Carolina State Department of Public Instruction, Division of Vocational Education. [ERIC ED 268 345]

________. (1985). Industrial arts curriculum guide for automated machining in metals technology. Hartford, CT: Connecticut State Department of Education, Division of Vocational and Adult Education. [ERIC ED 263 390]

________. (1985). Industrial technology competencies. Santa Fe, NM: New Mexico State Department of Education.

________. (1985). Production technology: Illinois plan for industrial education. DeKalb, IL: Northern Illinois University.

________. (1985). Resources in technology: Volume 2. Reston, VA: International Technology Education Association.

________. (1985). Science & math concepts corequisite or prerequisite to competencies in communications technology, energy utilization technology, production technology & transportation technology. DeKalb, IL: Northern Illinois University. (Activities)

________. (1985). Vocational education curriculum guide: Automated machining in metals technology. Baton Rouge, LA: Louisiana Department of Education.

________. (1986). CITE: Materials & processing -- construction/wood. Muncie, IN: Indiana Department of Industry and Technology and Ball State University. A & B (Activities).

________. (1986). Communications technology. Salt Lake City, UT: Utah State Department of Education.

________. (1986). Computer utilization inindustrial arts/technology education: A curriculum guide. Hartford, CT: Connecticut State Department of Education. [ERIC ED 275 828]

________. (1986). Construction technology. Salt Lake City, UT: Utah State Department of Education.

________. (1986). Energy--power-transportation. Salt Lake City, UT: Utah State Department of Education.

________. (1986). High school industrial arts. Salem, OR: Oregon Department of Education.

________. (1986). Industrial arts/technology education program guide. Salt Lake City, UT: Utah State Department of Education.

________. (1986). Industrial education guide for elementary and secondary program development and improvement in industrial arts, K-12. Pierre, SD: South Dakota State Division of Elementary and Secondary Education. [ERIC ED 275 861]

________. (1986). Introduction to technology. Albany, NY: New York State Education Department. (Activities)

________. (1986). Introduction to technology: Technology learning activities. Albany, NY: New York State Education Department. (Activities)

________. (1986). Manufacturing technology. Salt Lake City, UT: Utah State Department of Education.

________. (1986). Resources in technology: Volume 3. Reston, VA: International Technology Education Association.

________. (1986). Technology activities, Idea book 1. Reston, VA: International Technology Education Association.

________. (1986). Technology modules. Morgantown, WV: West Virginia Department of Education.

________. (1987). Career information center. Mission Hills, CA: Glencoe.

________. (1987). Resources in technology: Volume 4. Reston, VA: International Technology Education Association.

________. (1987). The model industrial technology systems project. Columbus, OH: Ohio State Department of Education, Bowling Green State University. [ERIC ED 284 037]

________. (1988). CITE: Materials & processing -- construction/wood. Muncie, IN: Indiana Department of Industry and Technology and Ball State University. A & B (Activities)

________. (1988). Resources in technology: Volume 5. Reston, VA: International Technology Education Association.

________. (1988). Technology education guide. Albany, NY: State Education Department. (Activities)

________. (1988). Technology education in Pennsylvania. Harrisburg, PA: Pennsylvania Department of Education, Technology Education Association of Pennsylvania.

________. (1988). TSA competitive events guidelines. Reston, VA: Technology Student Association.

________. (n.d.). AIASA guide for industrial education programs. No. 278c. Springfield, IL: Illinois State Board of Education.

________. (n.d.). Career planning workbook: From astronaut to zoologist. Madison, WI: The Vocational Studies Center. CSK203

________. (n.d.). Concrete materials proportioning. Columbia, MO: University of Missouri-Columbia, Instructional Materials Laboratory. 10-7153-A

________. (n.d.). Construction systems. Madison, WI: State Department of Education.

________. (n.d.). Diversified Technology. Twenty module technology activity series. Jackson, MS: Mississippi State Department of Education, Vocational Bureau.

________. (n.d.). Encyclopedia of careers and vocational guidance. Chicago, IL: J. G. Ferguson.

________. (n.d.). Energy efficient construction technology. East Lansing, MI: Michigan Career Education and Vocational Education Resource Center, Michigan State University. MT-IA-2.

________. (n.d.). Exploring computer technology. Chicago, IL: Illinois State Board of Education. (Activities)

________. (n.d.). Glass and glazing: An introduction to the architectural glass trade. McLean, VA: National Glass Association.

________. (n.d.). Guide for occupational exploration. Circle Pines, MN: American Guidance Service.

________. (n.d.). Industrial arts: Production technology. Salt Lake City, UT: Utah State Board for Vocational Education.

________. (n.d.). Industrial education: A three level instructional guide: Woods. Topeka, KS: Kansas State Department of Education.

________. (n.d.). Industrial enterprise handbook. Madison, WI: Bureau for Vocational and Career Education, Division of Instructional Services, Wisconsin Department of Public Instruction.

________. (n.d.). Industry and technology education: A guide for curriculum designers, implementors and teachers. Lansing, IL: Technical Foundation of America. (Activities)

________. (n.d.). Manufacturing systems. Madison, WI: Wisconsin State Department of Education.

________. (n.d.). Michigan technology education curriculum supplement. East Lansing, MI: Michigan Career Education and Vocational Education Resource Center, Michigan State University. MT-IA-6.

________. (n.d.). Michigan technology education curriculum. East Lansing, MI: Michigan Career Education and Vocational Education Resource Center, Michigan State University. MT-IA-3.

________. (n.d.). PACE: Program for acquiring competence in entrepreneurship. Revised Level 1, 18 module series for secondary programs. Columbus, OH: The Center for Education and Training for Employment, The Ohio State University. RD240A

________. (n.d.). Robotics/Michigan industrial arts curriculum handbook. East Lansing, MI: Michigan Career Education and Vocational Education Resource Center, Michigan State University. MT-IA-1.

________. (n.d.). Sex equity guide for industrial education programs. No. 278d. Springfield, IL: Illinois State Board of Education.

________. (n.d.). Special needs guide for industrial education programs. No. 279e. Springfield, IL: Illinois State Board of Education.

________. (n.d.). Using the language of industry. Chicago, IL: Illinois State Board of Education. (Activities)

American Society of Nondestructive Testing. (1980). Recommended practice. SNT-TC-1A.

Amrine, H. K.; Ritchey, J. A. & Moodie, C. L. (1987). Manufacturing organizations and management. NJ: Prentice-Hall. ISBN # 0-13-5558144-x 025.

Anderson, J. G. (1983). Technical shop mathematics. New York: Industrial Press. ISBN-0-8311-1145-3 [Reference]

Anderson, R. & Carter, L. (November, 1985). Robot construction using inexpensive materials. Industrial education. pp. 22-23.

Baird, R. J. & Baird, D. T. (1986). Industrial plastics. South Holland, IL: Goodheart-Willcox.

Bame, A. & Cummings, P. (1988). Exploring technology. Worcester, MA: Davis. ISBN # 0-87192-196-0.

Barnes, J. L. (1984). Systems of technology: Energy technology. Austin, TX: Texas Education Agency. (Activities)

Barnes, J. L. (1986). Laboratory activities for production -- systems of technology series. Austin, TX: Texas Education Agency.

Bender, M. (1977). North Dakota industrial arts introduction: Curriculum guide level 1. Bismarck, ND: North Dakota State Board for Vocational Education. (Activities)

Betts, M. R.; Hauenstein, A. F. & Fannin, J.W. (1976). Exploring the construction industry. Bloomington, IL: McKnight.

Betz, C. E. (1969). Principles of penetrants. Chicago, IL: Magnaflux. Catalog Card #76-95933.

Boben, D. K. (1985). Guidelines for equity issues in technology education. Reston, VA: International Technology Education Association.

Boyes, W. E. (1979). Jigs and fixtures. Dearborn, MI: Society of Manufacturing Engineers. ISBN # 0-87263-051-X.

Cabaup, B. M. (1989). Activities for the occupational outlook handbook. Bloomington, IL: Meridian Education Corporation. ISBN - 0-937007-24-9. (Activities)

Career Planning and Placement Center. (1986). CPPC information series #73. Columbia, MO: University of Missouri-Columbia.

Claus, R. et al. (1981). Industrial crafts (production). Industrial arts, senior high--level II. North Dakota senior high industrial arts curriculum guides. Grand Forks, ND: University of North Dakota, Department of Industrial Technology. [ERIC ED 209 518]

Claus, R. et al. (1981). Plastic technology (production). Industrial arts, senior high--level II. North Dakota senior high industrial arts curriculum guides. Grand Forks, ND: University of North Dakota, Department of Industrial Technology. [ERIC ED 209 519]

Claus, R. et al. (1981). Wood technology (production). Industrial arts, senior high--level II. North Dakota senior high industrial arts curriculum guides. Grand Forks, ND: University of North Dakota, Department of Industrial Technology. [ERIC ED 209 520]

Clendenning, L. R. & Dickey, O. W. (1983). Technology, free enterprise, and careers through industrial arts. Mount Berry, GA: Berry College and Georgia State Education Department. [ERIC ED 236 361] (Activities)

Collier, P. & Horowitz, D. (1987). The Fords. New York: Summit. ISBN # 0-671-54093-9.

Como, J. (1983). Surviving on the job. Mission Hills, CA: Glencoe.

Cope, D. & Schaude, L. (1982). Plastics. South Holland, IL: Goodheart-Willcox.

Daggett, W. (1989). The dynamics of work. Cincinnati, OH: South-western Publishing Co.

Daniel, C. (1986). Roof truss strength test. CITE Module. Muncie, IN: Ball State University.

Darrow, D. & Pine, D. (1980). Iowa industrial arts handbook for introductory level production. Des Moines, IA: Iowa Department of Public Instruction. (Activities)

DeVore, P., Horton, A. & Lawson, A. (1989). Creativity, design & technology. Worchester, MA: Davis.

Diaz, L. F., Savage, G. M. & Golueke, C. G. (1982). Resource recovery from municipal solid wastes: Primary processing. Richmond, CA: Cal Recovery Systems. vol 1 & 2, ISBN-0-8493-5613-X [Reference]

Dietz, D. W, Woods, S & Gober, I. (1989). The Texas Longhorn Project: Multi-school entrepreneurship and manufacturing unit for technology education. Presentation at ITEA conference, Dallas. Gainesville, Denton, Austin, TX: Author (P.O. Box 9465, Austin, TX 78766)

Donovan, B. et al. (1987). Exploring technology education. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

Doty, C. R. (1985). Preparing for High Technology: Model Programs in the USA. Columbus, OH: Ohio State University, National Center for Research in Vocational Education. [ERIC ED 268 390]

Ducheyne, P. & Hastings, G. W. (eds.). (1984). Metal and ceramic biomaterials. Stoke-on-Trent, England: North Staffordshire Polytechnic, Hartshill. vol 1, ISBN-0-8493-6261-X [Reference]

Dyrenfurth, M. J. & Linhardt, R. (1981). Vocational safety guide. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

Dyrenfurth, M. J. et al. (1987). Missouri industrial technology education guide. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

Ebert, S. et al. (n.d.). Safety education handbook. Johnson, KS: Kansas State Department of Education. vol.1 - 3.

Educational Testing Service. (1985). SIGI-Plus: A guide to further resources. Princeton, NJ: ETS.

Fales, J. F. ; Kuetemeyer, V. F. & Brusic, S. K. (1987). Technology: Today and tomorrow. Mission Hills, CA: Glencoe. ISBN 0-02-677020-2.

Falk, R. F. (1976). Industrial enterprise. Madison, WI: Wisconsin Bureau for Vocational and Career Education.

Farr, J. M. et al. (1987). The work book: Getting the job you want. Mission Hills, CA: Glencoe.

Feirer, J. L. & Hutchings, G. R. (1986). Carpentry and building construction. Mission Hills, CA: Glencoe.

Firenze, R. J. & Walters, J. B. (1981). Safety and health for industrial/vocational education supervisors and instructors. Cincinnati, OH: Washington, D.C.: National Institute for Occupational Safety and Health, Division of Training and Manpower Development, Occupational Safety and Health Administration. [ERIC ED 217 204]

Frame, D. (1988). Industrial technology at Riverview Gardens. St. Louis, MO: Riverview Gardens High School (314: 869-4700).

Gemmill, L. (1987). Truss stiffness testing -- Torsion. CITE Module CO-P-019. Muncie, IN: Ball State University.

Gido, J. (1985). An introduction to project planning. New York: Industrial Press. ISBN-0-8311-1160-7 [Reference]

Goetsch, D. L. & Nelson, J. A. (1987). Technology and you. Albany, NY: Delmar. ISBN 0-8273-2662-9.

Goetsch, D. L. (1988). The CAD/CAM workbook. Albany, NY: Delmar.

Gourley, J. T. & Micklus, S. C. (1984). Problems! problems! problems! Discussions and activities designed to enhance creativity. Glassboro, NJ: Creative Competitions.

Gray, G. (1986). Constructing trusses. CITE Module CO-W-014. Muncie, IN: Ball State University.

Hacker, M. & Barden, R. A. (1987). Technology in your world. Albany, NY: Delmar. ISBN # 0-8273-2655-6.

Hacker, M. & Barden, R. A. (1988). Living with technology. Albany, NY: Delmar.

Harms, H. (1988). Technology activity series. Communication technology; Energy, power and transportation technology; Construction technology; Manufacturing technology. Albany, NY: Delmar. (Activities)

Hart, D. et al. (1987). Missouri student activities guide. Jefferson City, MO: Industrial Technology Education, Department of Elementary and Secondary Education. (Activities)

Henak, M. R. (1985). Exploring construction. Instructor guide, Student manual._South Holland, IL: Goodheart-Wilcox. ISBN # 0-87006-537-8/6.

Henriksen, E. K. (1973). Jig and fixture design manual. New York: Industrial Press. ISBN-0-8311-1098-8 [Reference]

Hoffman, E. G. (comp.). (1986). Student's shop reference handbook. New York: Industrial Press. ISBN-0-8311-1161-5 [Reference]

Holland, L. J. (1985). The occupations finder. Odessa, FL: Psychological Assessment Resources.

Holland, L. J. (1985). The self-directed search: A guide to educational and vocational planning. Odessa, FL: Psychological Assessment Resources. pp. 1-14.

Hughes, L. R. (ed.). (1983). Energy systems. Austin,TX: Center for Occupational Curriculum Development, University of Texas at Austin.

Hunt, D. V. (1983). Industrial robotics handbook. New York: Industrial Press. ISBN-0-8311-1148-8 [Reference]

Huth, M. (1989). Construction technology. Albany, NY: Delmar.

Iley, J. et al. (1988). Exploring manufacturing technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

Instructional Materials Laboratory. (1989). IML Catalog. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

Jacob, J. A. & Ritz, J. M. (Fall 1981). Materials and processes technology: A foundation for technology education. The Journal of Epsilon Pi Tau. VII, N2, pp. 28-35.

Johnson, F. (1988). Metals technology CNC lathe. Kearney, MO: Kearney Senior High School.

Johnson, H. V. (1981). Technical metals. Peoria, IL: Bennett.

Karger D. W. & Walton M. H. (1982). Advanced work measurement. New York: Industrial Press. ISBN-0-8311- [Reference]

Kazanas, H. C. et al. (1983). Technology of industrial materials. Mission Hills, CA: Glencoe.

Kazanas, H.C.; Baker, G. E. & Gregor, T. G. (1981). Basic manufacturing processes. McGraw Hill Book. U.S: ISBN 0-07-033465-X.

Keeton, M. et al. (1983). Construction exploration. Practical arts instructor's manual. Competency-based education. Frankfort, KY: Kentucky Department of Education. [ERIC ED 249 386]

Keeton, M. et al. (1983). Industrial communications exploration. Practical arts instructor's manual. Competency-based education. Frankfort, KY: Kentucky Department of Education. [ERIC ED 249 389]

Keeton, M. et al. (1983). Manufacturing exploration. Practical arts instructor's manual. competency-based education. Frankfort, KY: Kentucky Department of Education. [ERIC ED 249 387]

Keseman, C. (1988). Introduction to industrial technology. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

Khaleel, I. A. (1985). Metals: Industrial arts curriculum guide. Columbia, MO: Instructional Materials Laboratory, University of Missouri-Columbia.

Kicklighter, C. E. (1984). Architecture: Residential drawing & design. South Holland, IL: Goodheart-Willcox.

Kimbrell, G. & Vineyard, B. S. (1986). Succeeding in the world of work. Mission Hills, CA: Glencoe.

Kirby, J. & Matt, S. R., (ed.). (1983). Study guide for TCT in industrial arts. Atlanta, GA: Georgia State Department of Education. [ERIC ED 235 149]

Kuschel, H. (1988). Exploring technology: Technology education curriculum for the South Callaway Middle School. Mokane, MO: South Callaway R-2 Schools.

Lacey, R. (1986). Ford. Boston, MA: Little Brown. ISBN # 0-316-51166-8.

Landers, J. M. (1982). A study of the plastics industry in Missouri. Final Research Report. Jefferson City, MO: Department of Elementary and Secondary Education. [ERIC ED 219 642]

Landers, J. M. (1983). Construction: Materials, methods, careers. South Holland, IL: Goodheart-Willcox.

Landers, J. M. (1984). A curriculum guide for industrial arts plastic technology: Intermediate and secondary level students. Columbia, MO: Industrial Materials Laboratory, University of Missouri-Columbia. [ERIC ED 247 389]

Lane, G. A. (ed.). (1983). Solar heat storage: Latent heat Materials. Midland, MI: Dow Chemical. vol 1, ISBN-0-8493-6585-6 [Reference]

Lauton, E. (1964). Industrial arts plastics. Peoria, IL: Bennet.

Listar, G. S. (1987, 88). Technology activity guides 1 & 2. Albany, NY: Delmar. (Activities)

Lux, D.; Ray, W.; Blankenbaker, K. & Umstadt, W. (1982). World of construction. Bloomington, IL: McKnight. ISBN # 87345-406-5, pp. 1-14.

Lux, D. & Ray, W. (1971). The world of manufacturing. Bloomington, IL: McKnight . ISBN # 87345-551-7.

Littrell, J. J. (1987). From school to work. South Holland, IL: Goodheart-Willcox.

Maley, D. (1986). Research and experimentation in technology education. Reston, VA: International Technology Education Association.

Maley, D. (1978). The industrial arts teacher handbook: Techniques, principles and methods. Boston, MA: Allyn & Bacon. pp. 11-92.

Maley, D. (ed.). (1985). Math/Science/Technology projects for the technology teacher. Monograph. Reston, VA: International Technology Education Association.

Malo, G. E. (1989). Technology workbook: Problem solving. Albany, NY: Delmar. (Activities)

Markert, L. R. (1989). Contemporary technology: Innovations, issues and perspectives. South Holland, IL: Goodheart-Willcox.

McCrory, D. L. & Maughan, G. R. (1985). Resources in technology. Worcester, MA: Davis.

Mehta, P. K. (1986). Concrete: Structure, properties and materials. Englewood Cliffs, NJ: Prentice Hall. ISBN # 0-13-167115-4-01.

Meys, J. W. (February, 1988). Add robotics -- without much expense. The technology teacher. pp. 25-28.

Midwest Products Company. (1986). Teaching with model bridge building programs. Detailed activity module. Hobart, IN: Midwest Products Co., 400 S. Indiana Street, P.O. Box 564, Hobart, IN 46342.

Miller, M. et al. (1987). Arizona industrial arts manufacturing technology: Teacher's curriculum guide. Phoenix, AR: Arizona State Department of Education. [ERIC ED 287 037]

More, H. D. & Kibbey, D. R. (1965). Manufacturing materials and processes. IL: Irwin. ISBN # 65-12419.

Muller, F. (n.d.). Basic robotics curriculum guide. Reston, VA: International Technology Education Association, Technology Bank #88-001.

Neddenriep, T. (October, 1987). Construct a robot simulator for use in the general shop. School shop. pp. 20-21.

Nelson, R. A. & Selvidge, L. R. (1986). The manufacturing enterprise: Free enterprise and education. Statesboro, GA: Southern University Press. (Activities)

Neville, A. M. (1973). Properties of concrete. New York: Wiley. ISBN # 0-470-63281-X.

O'Leary, B. O. (ed.). (1982). Space industrialization. Laguna Niquel, CA: vol 1 & 2, ISBN-0-8493-5890/1-6/4 [Reference]

Oliver, A. T. & Bradley, E. (1987). OM-AHA! Problems to develop creative thinking skills. Glassboro, NJ: Creative Competitions.

Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: Delmar.

Owen, E. (1987). Problem solving candle carrier. Muncie, IN: Ball State University.

Payne, J. (ed.). (1985). Curriculum guide for industrial technology. Austin,TX: Texas Industrial Arts Association. (Activities)

Pfeiffer, J. (ed.). (1988). The annual: Developing human resources. San Diego, CA: University Associates.

Pollock, D. D. (1981). Physical properties of materials for engineers. Buffalo, NY: State University of New York at Buffalo. vol 1-3, ISBN-0-8493-6201/2/3-6/4/2 [Reference]

Potter, T. & Guild, I. (1983). Robotics. Usborne New Technology Series. London, UK: Usborne.

Ritz, J. M. et al. (1980). Materials and processes technology. Norfolk, VA: Old Dominion University, Department of Vocational and Technical Education. [ERIC ED 192 117]

Ryan, J. et al. (1986). Choices & goals: An individualized career exploration computer program. Mission Hills, CA: Glencoe.

Rye, K. J. (1989). Creative group problem solving in technology education. Bellvue, WA: Author (206: 747-3263).

Salant, M. A. (1988). Introduction to robotics. St. Louis, MO: McGraw Hill.

Satterberg, J. (1975). Lightweight leaded glass lamp. Industrial Education. p.64-66.

Schmitt N. M. & Farwell, R. F. (1984). Understanding automation systems. Dallas, TX: Texas Instruments. ISBN # 0-672-27014-5.

Schwaller, A. (1989). Transportation, energy and power technology. Albany, NY: Delmar.

Shackelford, R. & Henak, R. (1983). Making IE facilities accessible to the physically handicapped. Reston, VA: International Technology Education Association.

Shackelford, R. & Henak, R. (1983). Safety system design for technology education. Reston, VA: International Technology Education Association.

Sheets, E. (1986). Technology activities. Cleveland, OH: Brodhead-Garrett Co.

Silvius, H. G. & Curry, E. H. (1967). Teaching successfully in industrial education. Bloomington, IL: McKnight.

Sinn, J. W. (1985). Computer numerical control: Instructional manual. Bismark, ND: North Dakota State Board for Vocational Education. [ERIC ED 262 267]

Sinn, J. W. (n.d.). Manufacturing technology: Teacher's handbook (North Dakota). Reston, VA: International Technology Education Association, Technology Bank #88-040.

Steele, G. E. (1962). Fiberglass projects and procedures. Bloomington, IL: McKnight.

Summitt, R. & Sliker, A. (1980). Wood. East Lansing, MI: Michigan State University. ISBN-0-8493-0234-X [Reference]

Swanson, R. S. (1965). Plastics technology,basic materials and processes. Bloomington, IL: McKnight & McKnight .

Swernofsky, N. (1989). Making technology work. Albany, NY: Delmar.

Thode, B. (1987). Technology education. A curriculum guide. Boise, ID: Idaho State Department of Education, Division of Vocational Education. [ERIC ED 286 039]

Todd, R.; McCrory, D., & Todd, K. (1985). Understanding and using technology. Worcester, MA: Davis. ISBN # 0-87192-165-0.

Tver, D. F. and Bolz, R. W. (1983). Robotics sourcebook and dictionary. New York: Industrial Press. ISBN-0-8311-1152-6 [Reference]

U.S. Department of Labor. (1989). Occupational outlook handbook. Washington, DC: Bureau of Labor Statistics, U.S. Department of Labor.

U.S. Department of Labor. (1986). Dictionary of occupational titles. Washington, DC: Bureau of Labor Statistics, U.S. Department of Labor.

Vare, E. A. (1989). Mothers of invention. New York: Quill.

Walker, W. F. (1969). Beginners guide to jig and tool design. New York: Hart.

White, G. R. (ed.). (1975). Basic concrete construction practices. New York: Wiley. ISBN # 0-471-67430-0, pp. 95, 253-272.

White, M. J. (1986). Industrial arts curriculum guide for plastics: An introduction to polymer technology/science. Hartford, CT: Connecticut State Department of Education, Division of Vocational, Technical and Adult Education.

Williams, C. F. et al. (1988). Technology for tomorrow. Cincinnati, OH: South-western Publishing Co.

Wood, J. (1987). Exploring construction technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

Wright, C. (May 1987). Making jigs and fixtures teaching tools. Industrial Education. pp. 39-43.

Wright, R. T. (1984). Manufacturing. IL: Goodheart-Wilcox. ISBN # 0-87006-493-2.

Wright, R. T. (1985). Exploring manufacturing. IL: The Goodheart-Wilcox. ISBN # 0-87006-533-5.

Wright, R. T. (1986). Evaluating product ideas. Muncie, IN: Ball State University.

Wright, R. T. (1986). Improving ideas through brainstorming. Muncie, IN: Ball State University.

Wright, R. T. (1986). Modeling product solutions. Muncie, IN: Ball State University.

Wright, R. T. (1987). Programming a robot. CITE Module series. Muncie, IN: Ball State University.

Wright, R. T. (1987). Tea robot. CITE Module series. Muncie, IN: Ball State University.

Yoshioka, R. (ed.). (1987). Thousands of science projects. Classified titles of exhibits shown at science fairs and/or produced as projects for the Westinghouse Science Talent Search. Washington, DC: Science Service.

Wright, R. T. & Henak, R. M. (1985). Exploring production. IL: Goodheart-Wilcox. ISBN # 0-87006-530-0.

Young, L. H. & Winterberger, C. (1987). Guidelines for selecting simulation software products for teaching manufacturing concepts and practices. College Station, TX: Department of Industrial, Vocational and Technical Education, Texas A & M University.

Young, L. H. & Winterberger, C. (1989). Sample simulation instructional exercises. College Station, TX: Texas A & M University, Department of Industrial, Vocational and Technical Education.

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(312) 381-1840

School Scene
Technology Student Association
1914 Association Dr.
Reston, VA 22091
(703) 860-9000

School Shop
416 Longshore Dr.
P. O. Box 8623
Ann Arbor, MI 48107
(313) 769-1211

Science 84
American Association for the Advancement
of Science
1515 Massachusetts Ave N.W.
Washington, DC 20005
(202) 326-6400

T.H.E. (Technological Horizons in Education) Journal
Information Synergy, Inc.
2626 S. Pullman
Santa Ana, CA 92705
(714) 261-0366

The Technology Teacher
International Technology Education
Association (ITEA)
1914 Association Drive
Reston, VA 22091-1502
(703) 860-2100

TIES Magazine (Technology, Innovation & Entrepreneurship for Students)
TIES Project
College of Design Arts
Drexel University
Philadelphia, PA 19104
(215) 566-2880

Vocational Education Journal
American Vocational Association
1410 King Street
Alexandria, VA 22314
(703) 683-3111

Wood & Wood Products
Vance Publishing Corporation
400 Knightsbridge Parkway
Lincolnshire, IL 60069

Part 3: Publishers

American Association for Vocational Instructional Materials
The National Institute for Instructional Materials
120 Driftmier Engineering Center
Athens, GA 30502
(800) 228-4689

Davis Publication, Inc.
50 Portland St.
Worcester, MA 01608
(617) 754-7201

Technology Education textbooks, teacher guides, and activity manuals for middle/junior high school through college; resource books for elementary through college educators.

Delmar Publishers Inc.
2 Computer Dr. West
P.O. Box 15-015
Albany, NY 12212
(518) 459-1150
(800) 347-7707

Missouri Representative
John Hutchinson
9518 Lambert Terrace
St. Louis, MO 63134
(314) 426-2945

Up-to-date technology, vocational, technical and industrial technology textbooks, instructor guides and student workbooks.

Glencoe Publishing Company
809 W. Detweiller Dr.
Peoria, IL 61615
(309) 691-4454

Texts, support materials, and audio visuals for technology, vocational, technical and industrial technology.

Goodheart-Willcox Co., Inc.
123 W. Taft Dr.
South Holland, IL 60473
(312) 333 7200

Textbooks,workbooks, visual masters and software for all areas and levels of technology education.

Hobar Publications
1234 Tiller Lane
St. Paul, MN 55112
(612) 633-3170

Instructional materials for Industrial Technology; books, videos, microcomputer programs, slide-cassette programs, tools and safety materials.

Instructional Materials Laboratory
Room 10, London Hall
University of Missouri-Columbia
Columbia, MO 65211
(800) 392-7217

Wide range of Missouri-specific instructional materials for technology education, industrial technology, trade and industry and technical education.

McGraw-Hill Book Company/Gregg Division
1221 Avenue of the Americas
New York, NY 10020
(212) 512-4097

Trade and technical instructional materials in automotive, aviation, drafting, manufacturing, mechanical technology, construction, civil technology, tech math, tech physics, electricity and electronics.

Mid-America Vocational Curriculum Consortium
1500 W. Seventh Ave.
Stillwater, OK 74074
(405) 377-2000

Competency-based vocational instructional materials, "Exploring Technology Education" series includes communication, construction, energy, power, transportation and manufacturing.

Prakken Publications
416 Long Shore Drive
P.O. Box 8623
Ann Arbor, MI 48107
(313) 769-1211

Publishers of School Shop, Education Digest, and textbooks, reference books and workbooks for industrial, technical and vocational educators.

Prentice-Hall
College Division
Englewood Cliffs, NJ 07632
(201) 592-2000

Current college textbooks and manuals in the technology education field.

TAB Books, Inc.
Blue Ridge Summit, PA 17294-0580
(800) 233-1128

Wide range of science, engineering, craft, hobby technology and general interest books.

University Associates
San Diego, California

Annually publish a collection of human resource development exercises, simulationsa nd activities.

Vocational Marketing Services
18501 Carpenter Street
Homewood, IL 60430
(312) 799-6560

Unique collection of hard to find resources, books and videos of relevance to ITE.

Part 4: Media Sources

Agency for Instructional Technology
Box A, 1111 West Seventeenth St.
Bloomington, IN 47402
(812) 339-2203

The nonprofit Agency for Instructional Technology produces and distributes instructional video, software and printed materials such as "Principles of Technology," "Applied Communication" and "You, Me and Technology." "Exploring Technology Education" is presently being developed. Many of their products are available for loan through the MVRC or for purchase from the IML.

Bergwall Productions, Inc.
106 Charles Lindbergh Blvd.
Uniondale, NY 11553
(516) 222-1111
(800) 645-3565

Live action videos in carpentry, cabinetmaking, Autocad, electronics; filmstrips and video transfers in technology education, electronics, metal machine and automotive technology. New series on manufacturing and exploring technology.

Career Aids
20417 Nordhoff Street
Department ND
Chatsworth, CA 91311
(818) 341-2535

Curriculum Instructional Materials Center (CIMC)
1500 West Seventh
Stillwater, OK 74074-4364
(800) 654-4502

DCA Educational Products, Inc.
Kellers Church Rd.
P.O. Box 338
Bedminister, PA 18910
(215) 795-2841

Overhead transparencies, sound filmstrips, video cassettes and computer software for technical education.

Educator's Progress Service
214 Center Street
Randolph, WI 53956
(414) 326-3126

Publishes Educator's guide to: Free teaching aids, Free audio and video materials, Free films, FreefFilmstrips, Free science materials, Free guidance materials, Free computer materials, etc.

Genium Publishing Corporation
Department Ag 91
1145 Catalyn Street
Schenectady, NY 12303-1836
(518) 377-8854

Manufacturing materials and processing video tape series.

Hawkhill Associates, Inc.
125 East Gilman St.
Madison, WI 53703
(800) 422-4295

Science/Technology/Society sound filmstrips and video cassettes.

International Technology Education Association
1914 Association Drive
Reston, VA 22091-1502
(703) 860-2100

Compilation of resources related to technology education and it's implementation.
88-021 Washington State: Technology Education
88-071 Technology Education: Seven programs
88-072 Women in the machining industry
88-073 World Assembly interest sessions
88-074 Technological Studies
______ *A career for the 21st century (ITE Teacher Recruiting)*
______ *Technology Education: The New Basic*
______ *You can do it (Paxton student recruiting)*

Media Center
State Fair Community College
1900 Claredon Road
Sedalia, MO 65301
(816) 826-7100

Modern Talking Picture Service
5000 Park Street North
ST. Petersburg, FL 33709
(813)541-5763
(800)243-MTPS
FAX: 1-813-546-0681

National Audio Visual Center
Information Services GK
Washington, DC 20409
(310) 763-1896

Federal Government audiovisual films, slides, video tapes, etc.

Missouri Vocational Resource Center (MVRC)
10 London Hall
University of Missouri-Columbia
Columbia, MO 65211
(314) 882-2883
(800) 392-7217

•*AIT videos: Introduction to communication; Designing messages; Producing and transmitting messages; Evaluating Messages; Overview of energy and power; Conversion and measurement of energy and power; Transmission, Control and storage of power; Transportation systems; Overview of technology; People, technology and the environment; Introduction to manufacturing; Manufacturing systems; Using and evaluating materials; Manufacturing process; Manufacturing process planning; Introduction to construction; Designing and planning a structure; Building safely; Finishing a structure.*

•*Operation Leather: A computerized approach to classroom manufacturing and free enterprise. Includes instructor and student guides, video tape, computer diskettes for Apple & IBM.*

•*YMT videos: Living with technology, Decisions, decisions, decisions - information processing; The technology spiral; Energy for societies; Health and technology; Feeding the world - agricultural technologies; Communications; The changing romance - Americans and wheels; China, Japan and the west - Transfer of technologies; Population patterns and technology; Exploring space; Risk, safety and technology; Teachers inservice YMT.*

Teaching Aids Inc.
P. O. Box 1798
Costa Mesa, CA 92628-0798
(714) 548-9321

Instructional media and software, tests in technology, machine operation, safety, etc.

UMC Film Library
Academic Support Center
505 East Stewart RD.
University of Missouri-Columbia
Columbia, Mo. 65211
(314) 882-3601

Video Outreach
c/o JN Company
P.O. Box 388
Woodbury, NY 11797

Provides, courtesy of Phillips Petroleum, The search for solutions (nine videos) and American enterprise (five videos). Reproduction permitted.

Part 5: Resource Centers

Center for Education & Training for Employment
The Ohio State University
1900 Kenny Road
Columbus, Ohio 43210
(800) 848-4815

Large collection of vocational education resources.

Center for Implementing Technology
Education (CITE)
Department of Industry and Technology
Ball State University Muncie, IN 47306
(317) 285-5659

Collects, produces and disseminates technology education activities. The MVRC subscribes so they are available for review from this service.

Creative Competitions, Inc.
P.O. Box 27
Glassboro, NJ 08028.

Curriculum Instructional Materials Center (CIMC)
1500 West Seventh
Stillwater, OK 74074-4364
(800) 654-4502

Illinois Vocational Curriculum Center
Sangamon State University. F-2
Springfield, IL 62708
(217) 786-6375

International Apple Core, Public Domain Library
908 George Street
Santa Clara, CA 95134
(408) 262-9114

Minnesota Educational Computing
Consortium (MECC), Department 2B
3490 Lexington Ave North
St. Paul, MN 55126
(800) 228-3504

Computer software and related items.

Microcomputer Software Exchange
Mathematical Association of America
Department of Mathematics
University of New Haven
West Haven, CT 06516
(203) 932-7250

Missouri Vocational Resource Center
(MVRC)
10 London Hall
University of Missouri-Columbia
Columbia, MO 65211
(314) 882-2883
(800) 392-7217

MIX, The McGraw-Hill Information Exchange
McGraw-Hill, 29th Floor
1221 Avenue of the Americas
New York, NY 10020
(212) 512-4921

Mid-Continent Region Representative
(314) 256-2222

Technology Education communication data base service, accesses to Technology Link.

National Public Domain Software Center
1533 Avohill Street
Vista, CA 92084
(619) 727-1015

National Software Lending Library
507 Race Street
Cambridge, MD 21613
(301) 221-0551

National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

Listing of United States Government related technical information and databases.

PC-SIG
1030 East Duane Street, Suite D
Sunnyvale, CA 94086
(408) 730-9291

Project SERVE
Sex Equity Resources for Vocational Education
10 London Hall
University of Missouri-Columbia
Columbia, MO 65211
(800) 392-7217
TBBS (800) 392-7219

Public Brand Software
P. O. Box 51315
Indianapolis, IN 46251
(800) 426-3475

Very large range of public domain IBM PC or compatible software. Many with direct application to ITE.

Public Domain, Inc.
5025 South Rangeline Road
West Milton, OH 45383
(513) 698-5638

Science Service
1719 N. Street, N.W.
Washington, DC 20036

SOFTSWAP
Computer Using Educators
P. O. Box 217104
Concord, CA 94527
(415) 685-7265

Software Exchange
Oakland Schools
2100 Pontiac Lake Road
Pontiac, MI 48054
(313) 858-2019

Software Library
Mail Order Department
North Central Regional Library
238 Old Station Road
Wenatchee, WA 98801
(509) 663-1117

Technology Education Development Unit
C/O John Martin and Martin Coleman
Salford University
Salford, M5 4WT, UL

The technology education development unit is involved in technology resource development for teachers and pupils. They are particularly interested in the possibilities of exchanging ideas and comparing approaches, staff exchanges to learn about technology approaches in each other's centres and development of resources that would be valuable in both the UK and the collaborator's country.

Technology Education Software Bank
International Technology Education Association (ITEA)
The Ohio State University
190 West 19th St.
Columbus, OH 43210
(614) 422-7471

The Big Red Apple Club
1105 South 13th Street, 103
Norfolk, NE 68701
(402) 379-4680

The Vocational Studies Center
University of Wisconsin-Madison
Publications Unit
964 Educational Sciences Building
1025 West Johnson Street
Madison, WI 53706
(608) 263-2929

Part 6: Sample Suppliers†

Advance Process Supply Company
400 N. Noble St.
Chicago, IL 60622
(312) 942-8538

Screen printing & graphic shop supplies: inks, supplies & state-of-the-art equipment.

Advanced Manufacturing Techniques, Inc.
P.O. Box 617
Clifton Park, NY 12065
(518) 877-8560

Structural Stress Analyzer to measure the force and deflection withstood by student-built model structures and can be used as a stand-alone unit of interfaces with a plotter or computer.

Advanced Center for Technology Trng (ACTT)
31000 Northwestern Highway
Farmington Hills, MI 48018
(313) 737-4730

Technology literacy, robotics and automation training programs, simulators, workstations and ORT modules.

Alvin & Company, Inc.
P.O. Box 188
Windsor, CT 06095
(203) 243-8991

Drafting, engineering, industrial arts and graphic arts supplies. General catalog contains over 12,000 items.

Anilam Electronics Corp.
5625 N.W. 79th Ave.
Miami, FL 33166
(305) 592-2727

CNC controllers and machines.

Arrow Safety
1007 Monitor St.
LaCrosse, WI 54603
(800) 284-2147

Safety products - protective glasses, goggles, hearing protection: first aid supplies, eye wash station, safety signs, cans, asbestos removal equipment, respirators, welding supplies, shop coats, fire blankets and extinguishers.

Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(415) 332-2344

AutoCAD PC-based CAD program, other Autodesk products include AutoSketch, a full function precision drawing tool; AutoCAD AEC series, which adapts AutoCAD to the architecture, construction, and engineering; AutoShade, which turns AutoCAD drawings into three-dimensional shaded images; CAD/camera, which facilitates the automatic transfer of paper drawings to CAD database; and Engineer Works, a solid modeling program.

Brodhead-Garrett Company
223 S. Illinois Ave.
Mansfield, OH 44905
(800) 321-6730

Equipment to teach industrial arts in the traditional and new technology methods. All tools, machinery and supplies and modern teaching aids offered, 1000 page catalog.

Budgetbytes
1647 SW 41st Street
Topeka,KS 66609
(800) 356-3551

Large selection of public domain and shareware software.

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†The project team acknowledges the assistance of the International Technology Education Association whose conference program book formed the initial basis for this expanded list.

C. M. Associates
P.O. Box 13374
Greensboro, NC 27408
(919) 375-7734

Air cleaning systems for the removal of hazardous contaminants found in wood shops, metal working, auto body and graphic art departments.

CADKEY
Division of Micro Control Systems
27 Hartford Turnpike
Vernon, CT 06066
(203) 647-0220

CADKEY three-dimensional drafting system for IBM and compatible microcomputers. Applications range from mechanical engineering design, drafting, analysis and manufacturing to technical illustration, graphic arts and bio-medical engineering - any design work requiring ANSI or ISO standards.

Career Research
65 W. Gordon Ave.
Salt Lake City, UT 84107
(801) 266-1441

Chown Hardware and Machinery
P.O. Box 2888
Portland, OR 97208
(800) 547-1930

Maintenance hardware, portable electric tools, hand tools and woodworking machinery for over 100 years.

CNC Software, Inc.
7212 S. Wapato St.
Tacoma, WA 98409
(206) 474-1850

MasterCAM industrial CAM package; 3-D milling, turning, internal drawing package, Cadlinks - AutoCAD, CADKEY, Versacad, Anvil.

Cope Plastics, Inc
4441 Industrial Drive
Godfry, IL 62035
(618) 466-0221
(800) 835-0686

Wide range of plastics supplies, equipment and tools.

Deft, Inc.
P.O. Box 2476
Alliance, OH 44601
(800) 458-3338

Wide range of Deft finishing supplies, stain and oil.

D & M Computing, Inc.
1010 32nd Ave., South
Moorhead, MN 56560
(218) 233-5172

Delta International Machinery Corporation
246 Alpha Dr.
Pittsburgh, PA 15238
(412) 963-2425

General-purpose woodworking machinery and accessories for use in industry, the building and construction trades, home and school shop.

Eastwood Company
P.O. Box 296
Malvern, PA 19355
(800) 345-1178

Unique materials and processing tools, primarily metal/automotive related.

Edmunds Scientific
101 E. Gloucester Pike
Barrington, NJ 08007
(609) 547 - 3488
(609) 573-6250

A wide array of hobbyist, scientific and technological supplies, materials, equipment, tools, instruction sets and kits, optics, mechanics, physics, chemistry, electronics, etc.

Emco Maier
2757 Scioto Parkway
P.O. Box 218120
Columbus, OH 43221
(800) 841-0626

Eshed Robotics, Inc.
45 Wall St.
Princeton, NJ 08540
(609) 683-4884

Robotics, robotic training integration with CNC, real-time work cell control and machine vision products, textbooks, workbooks, instructor manuals, AV materials, hardware and software.

Feedback, Inc.
620 Springfield Ave.
Berkeley Heights, NJ 07922
(210) 464-5181

Technology education products including robots, CIM cells, communication trainers. fiber optics, microprocessors, sensors, and control systems.

Fischer America Inc.
175 Route 46 West
Fairfield, NJ 07006
(800) 631-7131

1904 Oostburg Court
Modesto, CA 95356
(209) 575 -3445

Frank Paxton Lumber Company
2900 Bryan Ave.
Fort Worth, TX 76104
(817) 924-2224

General Electric (Super Abrasives)
GE Company
6325 Huntley Road, P.O. Box 568
Worthington, OH 43085
(614) 438-2461

Graymark
Box 5020
Santa Ana, CA 92704
(800) 854-7393

Electronic and robotic kits, components and instructional materials.

Graves-Humphreys
1948 Franklin Rd
Roanoke, VA 24033
(800) 631-0158

CAD/CAM packages operating on IBM or Apple IIe computers. Safety and machine maintenance videos, general supplies.

Hearlihy & Co.
714 W. Columbia St.
P.O. Box 869
Springfield, OH 45501
(513) 324-5721
(800) 622-1000

CAD, CAM, industrial technology computer software and videos for technical education, new computer-assisted drafting program.

Heathkit/Zenith Educational Systems
Hilltop Rd.
St. Joseph, MI 49085
(616)982-3205

Programmed learning courses in electronics and computer technology, test and experiment hardware, robotics, and associated software.

Hobar Publications
1234 Tiller Lane
St. Paul, MN 55112
(612) 633-3170

Instructional materials for Industrial Technology course, books, videos, microcomputer programs, slide-cassette programs, tools and safety materials.

Honatech, Inc.
185 Riverdale Ave.
Yonkers, NY 10705
(914) 423-2146

Plastics processing equipment, supplies and instructional material.

Industrial Arts Supply Company
5724 W. 36th St.
Minneapolis, MN 55416
(612) 920-7393

Materials and information, plastics, metals, wood, science and technology teaching aids for junior high, high school and college.

Jackson/Arden - MFASCO
P. O. Box 20
22900 E. Industrial Dr.
St. Clair Shore, MI 48080
(800) 221-9222

Safety glasses, visitor glasses, hearing protection, respirators, welding helmets, welding goggles, equipment and protective clothing.

Kelvin Electronics
Seven Fairchild Ave.
Plainview, NY 11803
(516)349-7620

Electronic components, robotic kits, computer kits, bar-code systems, instruments and technology education supplies and tools/

L. J. Technical Systems, Inc.
19 Power Drive
Hauppauge, NY 11788
(516) 234-2100

EMU automation package together with a range of electronics teaching systems including unique workbooks written for technology education.

LEGO Education Division
555 Taylor Rd.
Enfield, CT 06082
(800) 243-4870

LEGO models, interfaces to computers, mechanical kits, LOGO programs.

Light Machines Corporation
669 E. Industrial Park Dr.
Manchester, NH 03103
(603) 625-8600

SpectraLIGHT Lathe/Mill system, CAD/CAM/CNC training system with robot interface capabilities that integrates with Apple and IBM.

Magnaflux Corporation
7300 West Lawrence Avenue
Chicago, IL 60656
(312) 867-8000

Complete line of materials testing equipment and supplies.

McEnglevan Heat Treating & Manufacturing Company
708 Griggs St.
P.O. Box 31
Danville, IL 61834-0031
(217) 446-0941

Tilting crucible furnace, small electric metal melting furnace. Sand muller and molders bench.

Modern School Supplies, Inc.
P.O. Box 958
Hartford, CT 06143
(203) 243-9565
(800) 243-2329

Drafting, art and graphic art supplies and equipment for occupational education and industrial technology.

The Parke System
805 S. Devonshire Rd.
Springfield, MO 65802
(417) 883-0427

Self-directed, educationally efficient lab activities using current manufacturing processes and materials.

PASCO Scientific
1876 Sabre St.
Hayward, CA 94545
(415) 786-2800

Laboratory equipment; physics, mechanics, energy-related, lasers, microwaves and optics.

Paxton/Patterson
5719 W. 65th St.
Chicago, IL 60638
(800) 323-8484

CAD/CAM packages operating on IBM of Apple IIe computer, safety and machine maintenance videos, full line of supplies and equipment.

PITSCO
P.O. Box 1328
Pittsburg, KS 66762
(316) 231-0000
(800) 835-0686

Expanded line of technology education supplies covering computer graphics, robotics, lasers, radio-controlled models and software, new plastics division.

Point Control Company
P. O. Box 2709
Eugene, OR 97402
(503) 344-4470

Integrated CAM system for automatic code generation for any CNC machine; graphic interface for easy interactive tool path specification; macros, 3-D, animated tool path verification.

Pratt & Lambert
75 Tonawanda Street.
Buffalo, NY 14207
(816) 221-3400

Professional finishing products, clear lacquers, sanding sealers, stains, clear wood finishes, catalyzed varnish, pigmented lacquers, paint remover, touch-up spray cans, water reducible lacquers and hot spray lacquers.

Retco Alloy Company
880 Estes Ave.
Elk Grove Village, IL 60007
(312) 593-7770
(800) 722-3307

More than 10,000 items for the metal shop, machine shop and wood shop.

Rhino Robots, Inc.
308 S. State St.
P.O. Box 4010
Champaign, IL 61820
(217) 352-8485

Rhino Robotics XR-3 Robotic revolute arm and SCARA arm and peripheral accessories. Rhino Robot's "Robo Talk" robotic language and courseware .

Robotmart
4720 Boca Raton Blvd. Suite 101
Boca Raton, FL 33431
(407) 394-3577

Mini FMS systems, smart CAM systems.

Safety Rules Inc.
3727 Joan Drive
Waterloo, IA 50702
(319) 233-0917

Safety rules, supplies & equipment, lab apparel, safety tests and instructional materials.

Safranek Enterprises, Inc.
4005 El Camino Real
Atascadero, CA 93422
(805) 466-1563

Her-Saf panel router - safety in dadoing, Her-Saf air-vac clamps, carbide cutters and specialty products.

SATCO
924 S. Nineteenth Ave.
Minneapolis, MN 55404
(612) 370-2555

Wide range of supplies and equipment for the school shop.

Scientific Labs, Inc.
P.O. Box 803788
Houston, TX 77280
(800) 654-9750

Principles of technology equipment, "Introduction to Technology" CAI software package by IBM.

Shain/Shop-Bilt, Inc.
509 Hemlock St.
Phillipsburg, PA 16866
(814) 342-2820

Hard maple furniture for vocational, technical and industrial education. Drafting, computer, & art tables, work benches, tool storage cabinets, electrical benches, and science tables.

Stanley-Proto Industrial Tools
Division of the Stanley Works
14117 Industrial Park Blvd.
Covington, GA 30209
(404) 787-3800

Hand tools including sockets, wrenches, tape rule, screwdrivers, leather and canvas products, hammers and other miscellaneous hand tools.

Synergistic Technology Systems: PITSCO
P.O. Box 1701
Pittsburg, KS 66762
(316) 231-1333

Technology modules, furniture, equipment , supplies and curricula.

The L.S. Starrett Company
121 Crescent St.
Athol, MA 01331
(617) 249-3551

Precision tools, micrometers, verniers, dial gages, electronic gages, surface plates, saw, M-1 oil, vises and educational videos.

The Science Instruments Company
6122 Reisterstown Rd.
Baltimore, MD 21215
(301) 358-7810

High technology laboratory panels, simulators, electronics and physics training equipment.

Tandy Leather Company
P.O. Box 2934
1400 Everman Parkway
Ft. Worth, TX 76113
(817) 551-9778
(800) 433-5546

Leather working supplies and tools, Operation Leather computer business simulation. Classroom demonstrations and training videos available at no charge to schools.

Technovate, Inc.
910 SW Twelfth Ave.
Pompano Beach, FL 33069
(305) 946-4470

Computer integrated manufacturing (CIM), strength of materials, fluid mechanics, heat transfer and equipment for most disciplines.

Tektron Equipment Corporation
530 Grand Island Blvd.
Tonawanda, NY 14150
(716) 832-8953

Printed circuit boards and processing equipment and supplies, instructional package, technical advice and support.

TII Robotic Systems
631 S, Vermont St.
Palatine, IL 60067
(312) 991-2636

Training systems, hardware and software for fluid power, robotics, controls and maintenance; from fundamentals to advanced technology.

Transtech Systems
Division of Creative Learning Systems, Inc.
9889 Hibert St., Suite E
San Diego, CA 92131
(619) 566-2880

Technology Lab 2000, integrated equipment and courseware for a computerized lab, transformable to meet the demands of evolving programs in future-oriented technology education.

Unilab, Inc.
9102 Industry Drive
P. O. Box 837
Unit I
Manassas Park, VA 22111
(703) 330-1997

Contemporary electronics, control systems, MEA microelectronics for all (problem-solving), Alpha prototype kits and supplies, micro-technology resources, POLYMEK and mechanical construction components.

Welsch Products, Inc.
1201 E. Fifth St.
P.O. Box 845
Benicia, CA 94510
(707) 745-3252

Thermal screens, print goccos, and related supplies for fast, easy screen printing on paper, wood, leather and textiles.

Testbed Technology, LTD
P. O. Box 70
The Science Park
Hulton Street
Blackburn, Lancashire, England BB1 3BY
(0254) 681444

Mechanical components, jigs, fixtures and modeling systems for technology education.

Woodworker's Supply of New Mexico
5604 Almeda Place, N.E.
Albuquerque, NM 87113
(800) 645-9292

Part 7: Associations

American Ceramic Society (ACerS)
757 Brooksedge Plaza Drive
Westerville, OH 43081
(614) 890-4700

American Concrete Institute (ACI)
P.O. Box 19150
Detroit, MI 48219
(313) 532-2600

American Forest Council (AFC)
1250 Connecticut Ave., N.W. Suite 320
Washington, DC 20036

American Foundrymens Society (AFS)
Golf and Wolf Roads
Des Plaines, IL 60016
(312) 824-0181

American Institute of Architects (AIA)
1735 New York Ave., N.W.
Washington, DC 20006
(202) 354-3300

American National Standards Institute
1430 Broadway
New York, NY 10018
(212) 838-9670

American Society for Mechanical Engineers
United Engineering Center
345 E. 47th Street
New York, NY 10017

American Society for Metals (ASM)
Metals Park, OH 44073
(216) 338-5151

American Vocational Association (AVA)
1410 King Street
Alexandria, VA 22314
(703) 683-3111

Associated Builders and Contractor, Inc.
729 15th Street N.W.
Washington, DC 20005
(202) 637-8800

Association of General Contractors of Missouri
P.O. Box 94
Jefferson City, MO 65102
(314) 636-3188

Industrial Arts Division (IAD)
American Vocational Association (AVA)
1410 King Street
Alexandria, VA 22314
(703) 683-3111

International Technology Education Association (ITEA)
1914 Association Drive
Reston, VA 22091-1502
(703) 860-2100

International Technology Education Association (ITEA)
Council of Supervisors
c/o William Kabakjian, Jr.
John F. Kennedy Center
734 Schuylkill Avenue
Philadelphia, PA 19146
(215) 875-3800

International Teleproduction Society (ITS)
990 Avenue of the Americas, Suite 21E
New York, NY 10018
(212) 629-3266

JETS, Inc.
Junior Engineering and Technology Society
1420 King Street, Suite 405
Alexandria, VA 22314
(703) 548-5387

Junior Achievement
45 Clubhouse Drive
Colorado Springs, CO 80906
(303) 540-8000

Missouri Industrial Technology Education Association (MITEA)
c/o Steve Coffman
P.O. Box 480
Jefferson City, MO 65102
(314)751-7764

Missouri Science Olympiad
c/o Becky Litherland
1206 East Walnut St.
Columbia, MO 65203
(314) 449-2882

Missouri Vocational Association (MVA)
101 Madison, Fourth floor
Jefferson City, MO 65101
(314) 634-7366

National Aeronautic & Space Administration (NASA)
Director of Secondary Programs
NASA Headquarters, Code XE
400 Maryland Avenue
Washington, DC 20540
(202) 453-1110

Regional center serving Missouri
Public Affairs, CA20
NASA Marshall Flight Center
Marshall Space Flight Center, AL 35812
(205) 544-6527

National Association for the Exchange of Industrial Resources (NAEIR)
Department IM
560 McClure St.
P. O. Box 8076
Galesburg, IL 61402
(309)343-0701

National Concrete Masonry Association
2302 Horse Pen Road
P. O. Box 781
Herndon, VA 22070-0781
(703) 435-4900

National Forest Products Association (NFPA)
1250 Connecticut Ave., N.W.
Washington, DC 20036

National Glass Association
8200 Greenhouse Drive, Suite 302
McLean, VA 22102
(703) 442-4890

National Hardwood Lumber Association (NHLA)
P.O. Box 34518
Memphis, TN 38184
(901) 377-1818

National Machine Tool Builders Association
7901 Westpark Drive
McLean, VA 22102
(703) 893-2900

National Paint and Coatings Association (NPCA)
1500 Rhode Island Avenue, N.W.
Washington, DC 20005
(202) 462-6272

National Safety Council (NSC)
444 N. Michigan Avenue
Chicago, IL 60611

Odyssey of the Mind
Creative Learning Systems, Inc.
9889 Hibert Street, Suite E.
San Diego, CA 92131
(800) 458-2880

Portland Cement Association (PCA)
5420 Old Orchard Road
Skokie, IL 60077
(312) 966-6200

Society of Manufacturing Engineers (SME)
P.O. Box 930
One SME Drive
Dearborn, MI 48121
(313) 271-1500
Society of the Plastics Industry (SPI)
1275 K Street, N.W., Suite 400
Washington, DC 20005
(202) 371-5200

Technology Student Association
1908 Association Dr.
Reston, VA 22091
(703) 860-9000

Part 8: Useful Forms

Name of Form	Intended Use
Technology Activity Module Blank Form	Teacher-developed
Lesson Plan Forms	TAMs & Lesson Plans
(note, both of these form sets are available in the Missouri Industrial Technology Education Guide)	
Unit Plan	Teacher overview
Corporation Stock Certificate	Business simulation
Flow Process Chart	Planning production
Operation Sheet	Planning production
Product Profile Chart	Planning production

UNIT NO. ____________

UNIT TITLE____

TOPIC	INFORMATION	HAND-OUT	ACTIVITY	TPs	REFERENCES

Adopted from Iley, J. et al. (1988). Exploring Manufacturing technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

____

Corporation

Stock Certificate

______________ is the registered owner of ____________________ share(s) of

________________ stock of this corporation.
(common -- preferred)

President: ______________

Treasurer: ______________

Date purchased: ______________

Purchase price per share: ________

FLOW PROCESS CHART

PRODUCT NAME ________________ CHART BEGINS ____________

PART NAME ________________ CHART ENDS ____________

PART NUMBER ___ DATE __/__/__

○ OPERATIONS ___ D DELAYS ___

□ INSPECTIONS ___ ▽ STORAGES ___

⇨ TRANSPORTATIONS ___ TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
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○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							

Adopted from Iley, J. et al. (1988). Exploring Manufacturing technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

OPERATION SHEET

Operation No. : ______ Product: ________________

Operation Name : ______________________

Part Name: ______________

Part No.: ______________

Quanity: ______________

Stock/ Material: ______________

____

Tools/ Equipment: ______________

____

____

Jigs / Fixtures: ______________

____

Supplies: ______________

____

____

Drawing of Major Details:

Operation Description:

Step No.	Description of Step	Materials	Machine	Tools and Equipment

Adopted from Iley, J. et al. (1988). Exploring Manufacturing technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

PRODUCT PROFILE CHART

PRODUCT NAME ______________ **PRODUCT TYPE** ______________

PRODUCT CONSIDERATIONS	**HIGH**			**LOW**	**DETAILS**
Product Need	4	3	2	1	
Product Utility	4	3	2	1	
Life Expectancy	4	3	2	1	
Product Uniqueness	4	3	2	1	
MARKET CONSIDERATIONS	**HIGH**			**LOW**	**DETAILS**
Size of Market	4	3	2	1	
Lack of Competition	4	3	2	1	
Who is the Market?					
PRODUCTION CONSIDERATIONS	**HIGH**			**LOW**	**DETAILS**
Ease of Production	4	3	2	1	
Equipment Availability	4	3	2	1	
Materials Availability	4	3	2	1	
Tooling Availability	4	3	2	1	
Inexpensive Tooling	4	3	2	1	
Ease of Setup	4	3	2	1	
Totals	+	+	+		= **TOTAL SCORE**

FINANCIAL CONSIDERATIONS:

Cost of Manufacturing (maximum) ______________

Selling Price ______________

Profit Margin ______________

SUMMARY:

____

____

Adopted from Iley, J. et al. (1988). Exploring Manufacturing technology.
Stillwater, OK: Mid-America Vocational Curriculum Consortium.

Part 9: Revision Form

Missouri Introduction to Materials & Processing Technology Guide

To maintain the value of this Introduction to M & P Technology Guide, members of the profession are encouraged to submit suggestions for additions, revisions and other modifications of any part of this document.

Section #: ______ Section Name: ______________________________

Part # _________ Part Name: ______________________________

My suggestion is a: ___ Revision ___ Addition ____ Other: ______________

My suggestion is to: (Attach pages and information as needed)

Mail to:

Missouri Industrial Technology Education Supervisor
Division of Vocational and Adult Education
Missouri Department of Elementary and Secondary Education
P.O. Box 480
Jefferson City, MO 65102